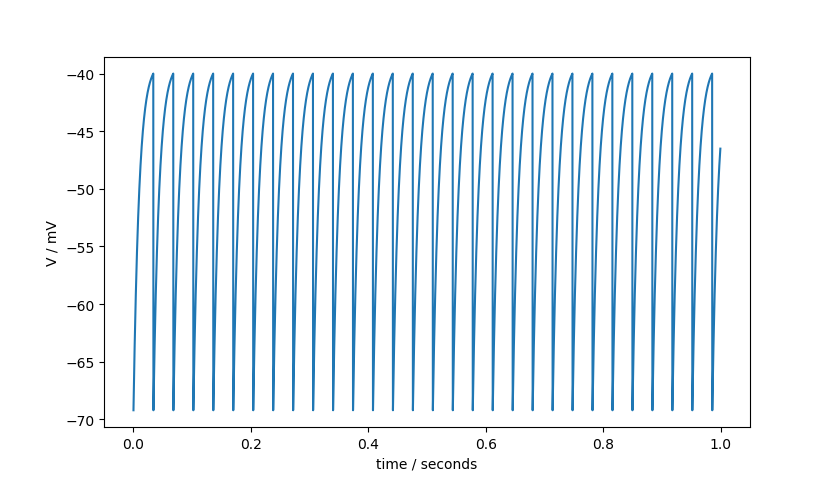
**Part A – Integrate-and-Fire Neurons**

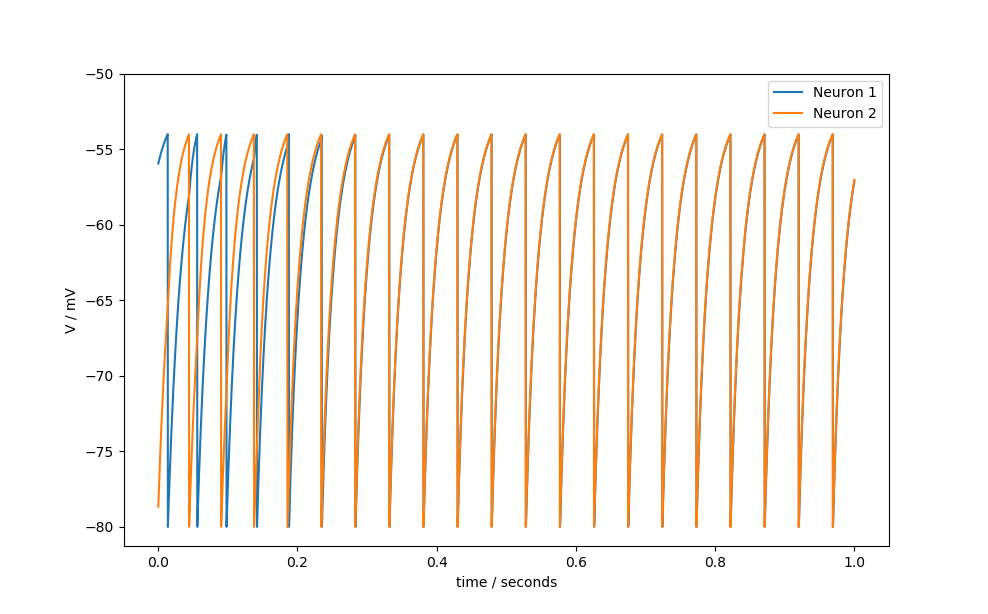
**Question 1**



Voltage / mV

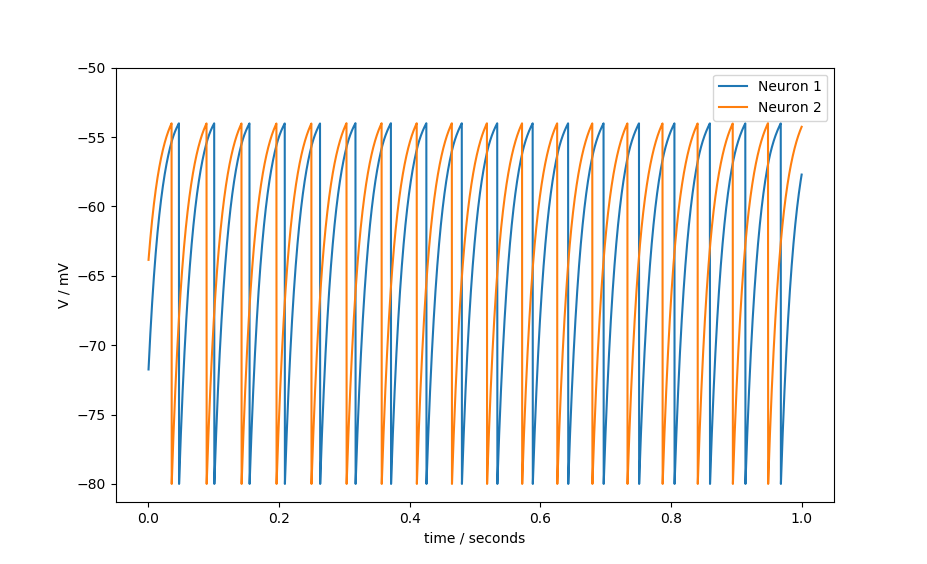
**Question 2**

***Neuron Voltage Over Time with Es = 0mV :***



Voltage / mV

***Neuron Voltage Over Time with Es = -80mV :***



Voltage / mV

For the excitatory synapses with Es = 0mV, we see the firing times of the two neurons converge after about 0.2 seconds.

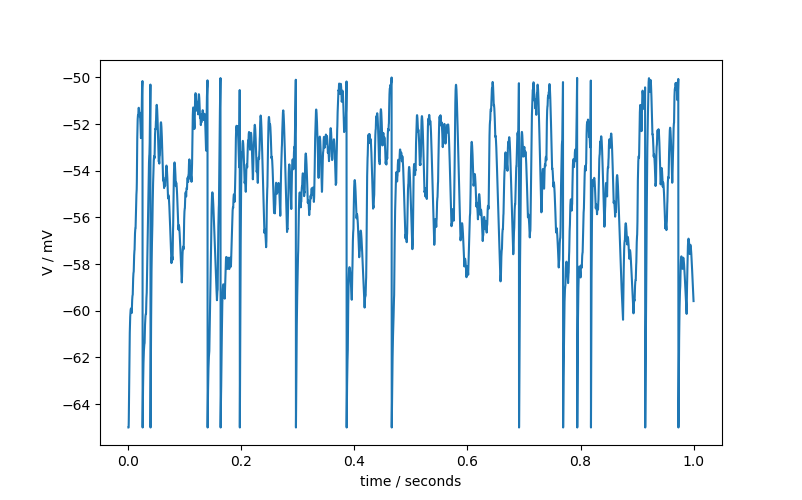
For the inhibitory synapses with Es = -80mV, we see the firing times of the two neurons seeming to separate from each other as time progresses.

An explanation for this behaviour could be down to the fact that for excitatory synapses they increase the probability of each neuron firing and as the neurons are connected, this increased firing rate causes the time difference between their respective spikes to decrease. One neuron firing causes the other to do so momentarily later due to the increased RmIs value resulting from this. This causes the converging of the firing times of the two neurons, eventually firing synchronously.  
With inhibitory neurons, the opposite is true. As the firing probability has been decreased, the RmIs value will stay at a decreased value for longer periods of time, meaning that firing rate for each neuron will be decreased. As the two neurons are connected, this causes the neurons to become asynchronous, with the time between neuron 1 and neuron 2 firing increasing over time.

**Part B – STDP**

**Question 1**

***Neuron’s Voltage for One Second***

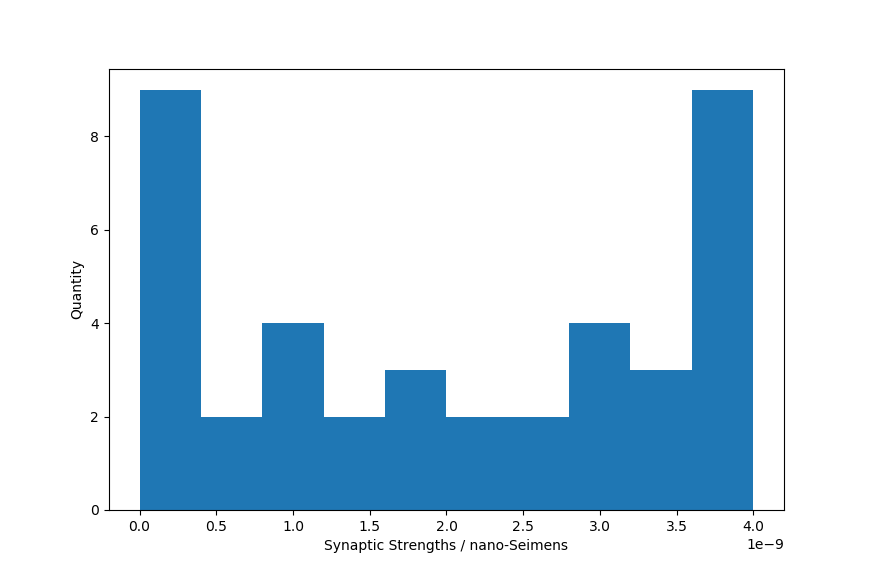


Voltage / mV

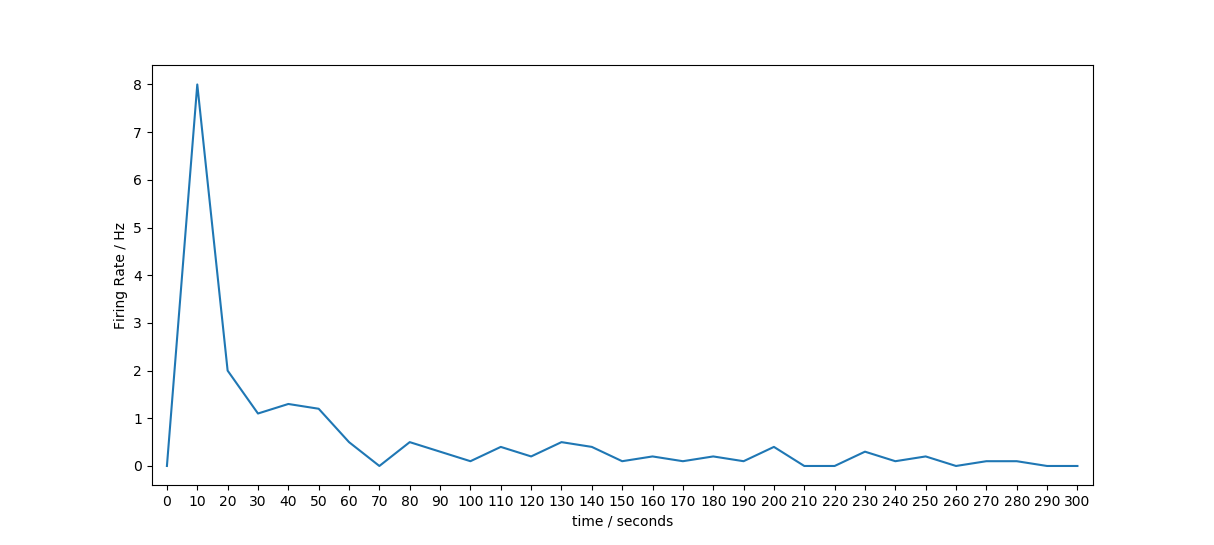
**Question 2**

The synaptic strength distribution at the end of simulation time of 300 seconds seems to converge to the minimum value (0 nano-Siemens) and the max value (4 nano-Siemens)

***Steady-State Synaptic Weights After Simulation Run :***



***Average Firing Rate of Postsynaptic Neuron (10 second time bins):***

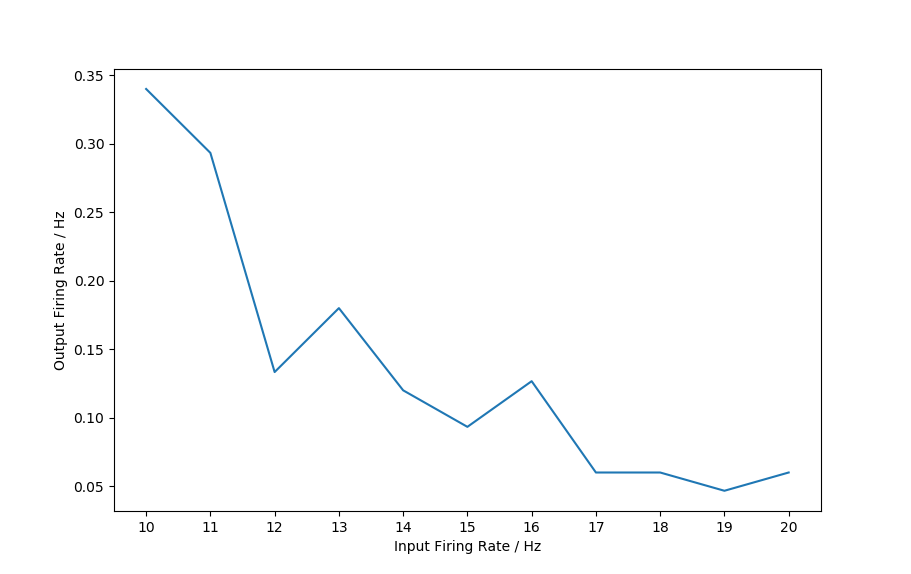


**Average Steady state firing rate for STDP ‘on’ (averaged over last 30 seconds) after 5 simulation runs** = (0.06666 + 0.16666 + 0.16666 + 0.13333 + 0.033333)/5 = 0.1133Hz

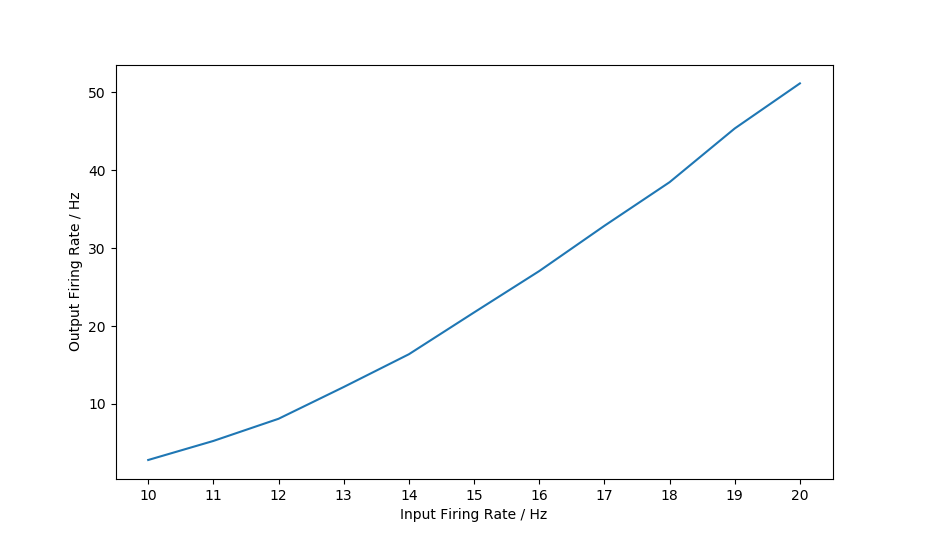
**Average Steady state firing rate for STDP ‘off’ (averaged over last 30 seconds) after 5 simulation runs** = (0.0 + 0.0 + 0.0 + 0.0 + 0.0)/5 = 0.0Hz

**Question 3**

***Mean Output Firing Rate STDP ‘on’ :***

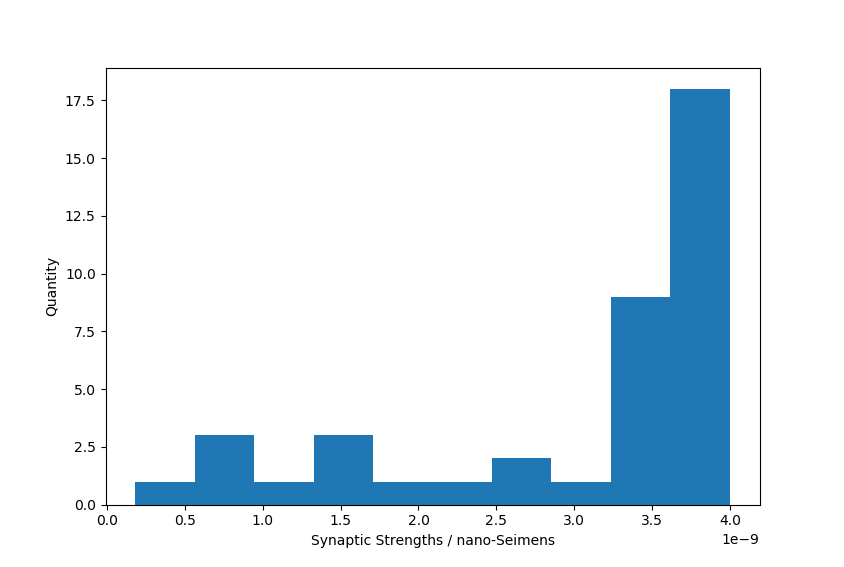


***Mean Output Firing Rate STDP ‘off’ :***

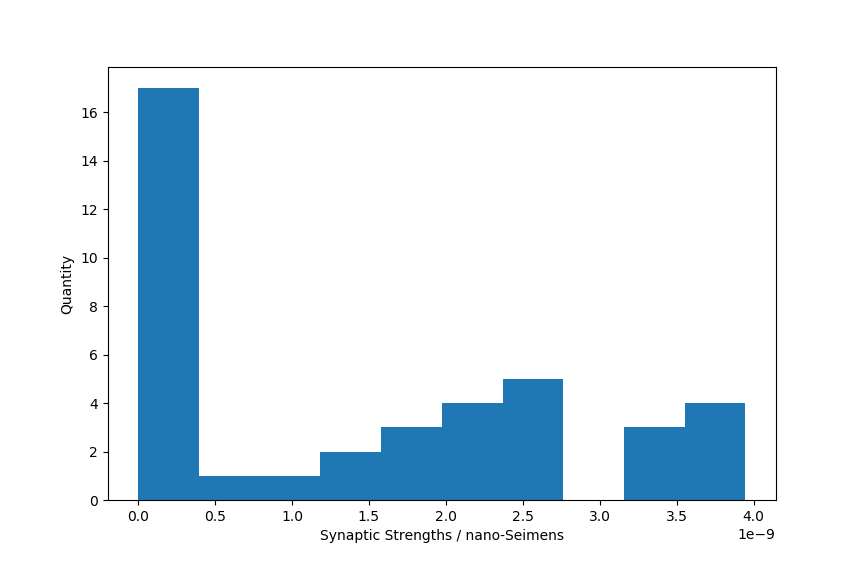


For STDP ‘on’, the steady-state output firing rate decreases as the input firing rate increases.  
For STDP ‘off’, the opposite is true, with steady-state output firing rate increasing as the input firing rate increases.

***Steady-State Synaptic Strength Distribution for Firing Rate = 10Hz, STDP ‘on’ :***



***Steady-State Synaptic Strength Distribution for Firing Rate = 20Hz, STDP ‘on’ :***

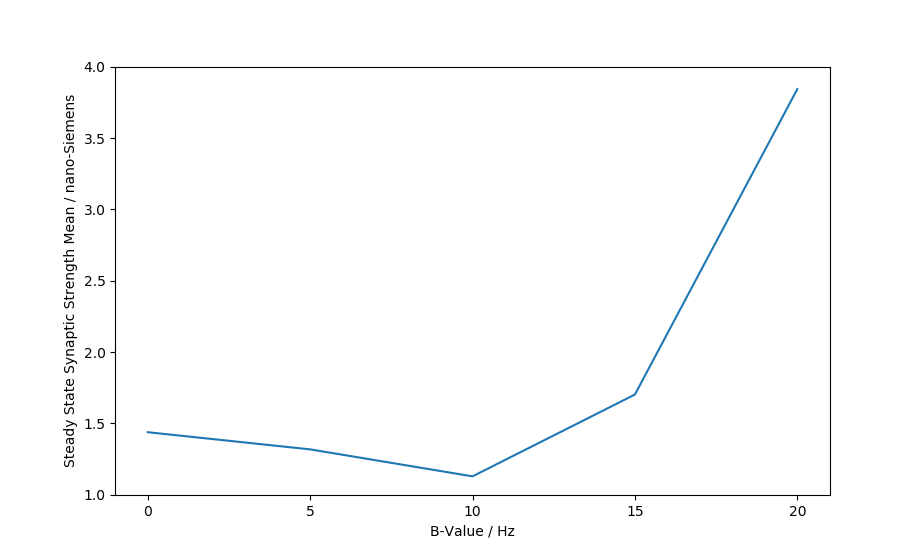


Explain what is happening. Why does this make sense?

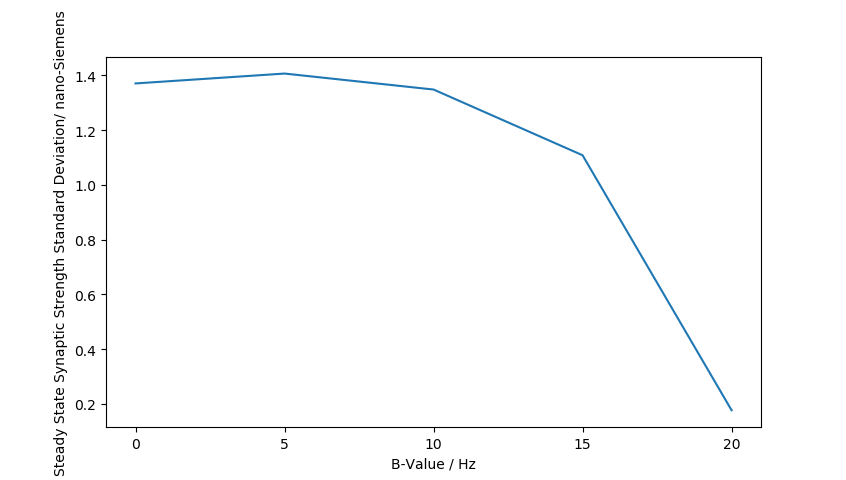
**Question 4**

The steady-state synaptic weights marginally decrease with degree of correlation between 0Hz and 10Hz. Between degree of correlation values of 10Hz and 20Hz, steady-state synaptic weights increase dramatically.

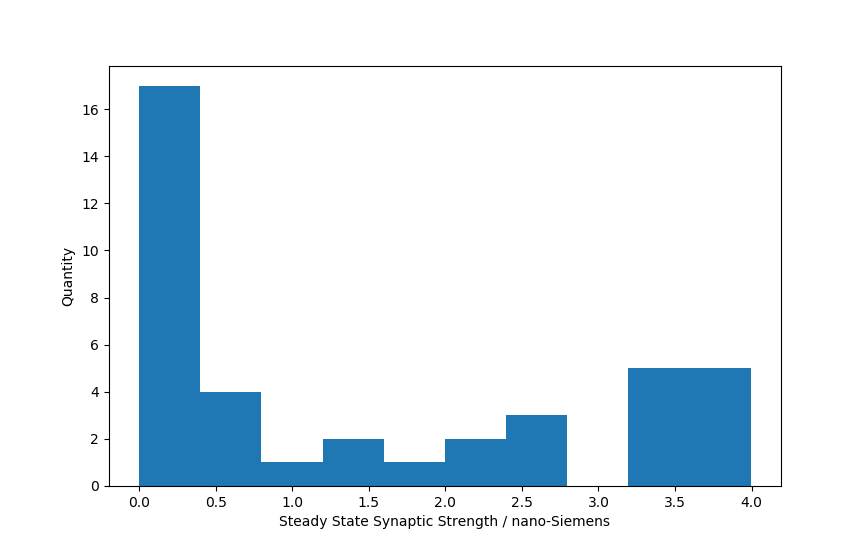
***Mean of Steady-State Synaptic Strengths :***



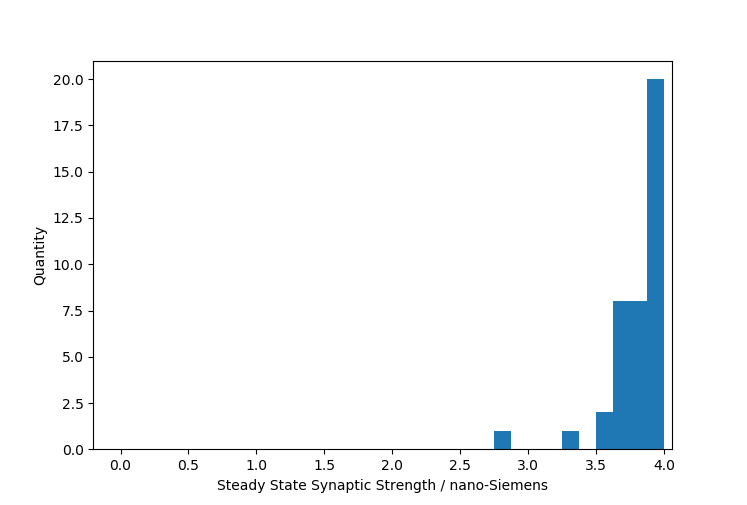
***Standard Deviation of Steady-State Synaptic Strengths :***



***Steady-State Synaptic Strengths for B = 0Hz :***



***Steady-State Synaptic Strengths for B = 20Hz :***



As the degree of correlation increases, we can see that the standard deviation also decreases dramatically past 10Hz…