Research Migration Project

https://esim.fossee.in/research-migration-project

Name of the Participate: BHUKYA BHARATH

Title of the Project: Neuromorphic Circuit Design of an Integrate-and-Fire Neuron with STDP Synapse

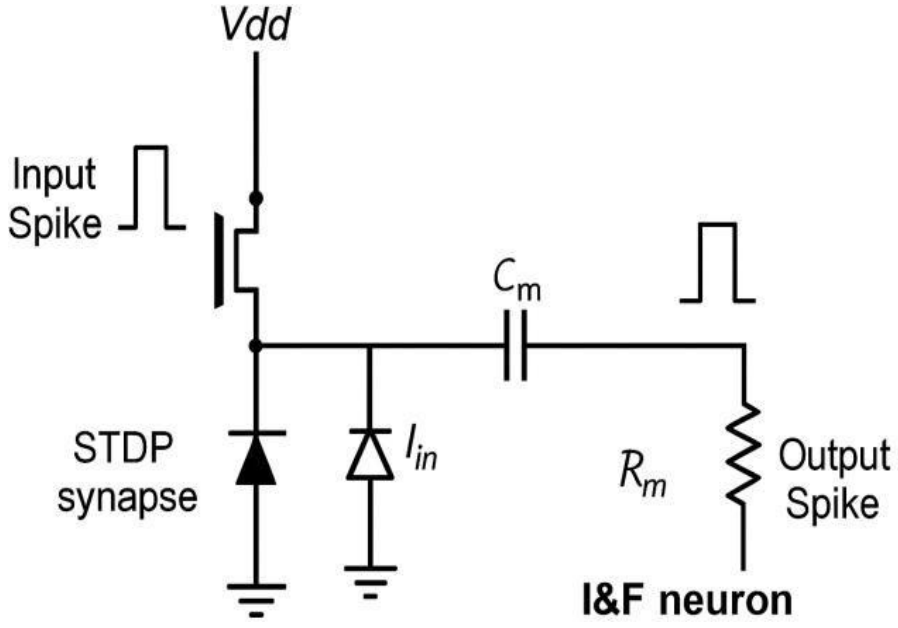
College Name: Vignana Bharathi Institutite of Technology

Theory:

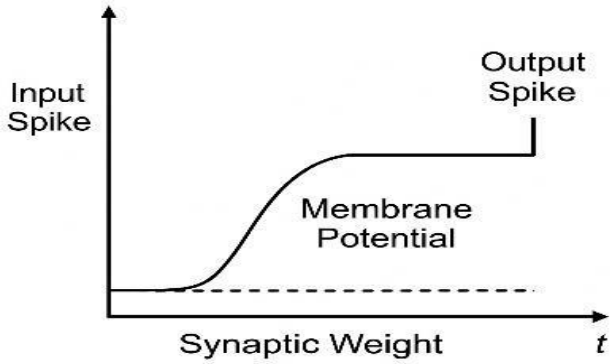
Neuromorphic circuits mimic the behavior of biological neurons and synapses for energy-efficient brain inspired computing. This work presents the design of an Integrate-and-Fire (I&F) neuron with a Spike-Timing Dependent Plasticity (STDP) synapse using the SG13G2 PDK in eSim with Ngspice simulation. The neuron integrates pre-synaptic inputs over time, firing when a threshold is reached, while the synapse dynamically adjusts its weight depending on the timing of pre- and post-synaptic spikes. The circuit demonstrates fundamental learning behavior and can serve as a building block for larger neuromorphic systems.

Keywords: Integrate-and-Fire Neuron, STDP, Neuromorphic Circuits, Synaptic Plasticity, eSim, Ngspice

Circuit Diagram:



Simulation results:
sample output waveform



Conclusion:. This work presents the design and simulation of an Integrate-and-Fire neuron with an STDP synapse, demonstrating biologically inspired learning behavior using eSim and Ngspice. The circuit successfully integrates input spikes, generates output firing, and adapts synaptic weights based on spike timing. It can serve as a basic building block for larger neuromorphic computing systems.

References:

1.eSim FOSSEE Project**, https://esim.fossee.in**
2.Mead, C., "Neuromorphic Electronic Systems," Proceedings of the IEEE, 1990.