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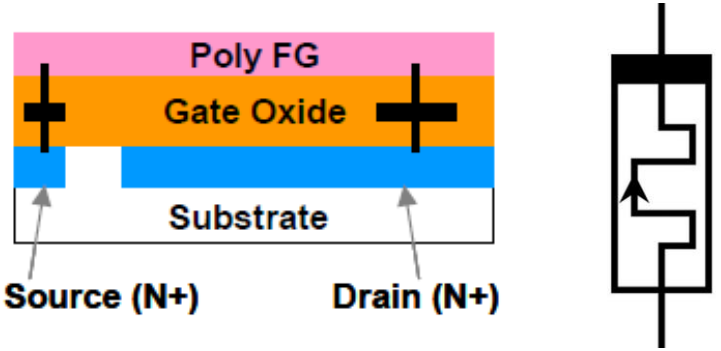
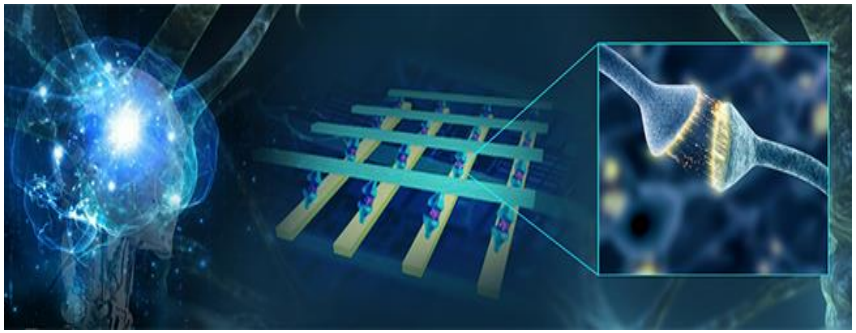
ASIC² Project:
Neural Network Training with Flash Arrays

Background: Artificial neural networks (ANN) became a common solution for a wide variety of problems in many fields, such as control and pattern recognition. Many ANN solutions reached a hardware implementation phase, either commercial or with prototypes, aiming to accelerate its performance. Recent work has shown that hardware implementation, utilizing nanoscale devices, may increase the network performance dramatically, leaving far behind their digital and biological counterparts, and approaching the energy efficiency of the human brain. The background of these advantages is the fact that in analog circuits, the vector-matrix multiplication, the key operation of any neuromorphic network, is implemented on the physical level. The key component of such mixed-signal neuromorphic networks is a device with tunable conductance, essentially an analog nonvolatile memory cell, mimicking the biological synapse. There have been significant recent advances in the development of alternative nanoscale nonvolatile memory devices, such as phase change, ferroelectric, and magnetic memories. In particular, these emerging devices have already been used to demonstrate small neuromorphic networks. However, their fabrication technology is still in much need for improvement and not ready yet for the large-scale integration, which is necessary for practically valuable neuromorphic networks. This project investigates a network prototype based on mature technology of nonvolatile floating-gate memory cells .





Project Description:

In this project students are required to model a Flash memory cell in its subthreshold domain to emulate memristive synapses in neural networks:

- Comprehension of Flash memory device, memristors, and ANN
- Physical modeling using Verilog-A of single-cell and arrays
- Behavioral modeling of ANN training and classification
- Wet-lab measurements of Flash arrays
- Experimental training and operation for small-scale ANN
- Performance evaluation of hardware ANN

Perquisites : linear electric circuits

Recommended : Introduction to VLSI

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VLSI Lab

The project in collaboration with TowerJazz

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