MOSFet Learning Materials

By completing the MOSFET Lab in ABACUS - Assembly of Basic Applications for Coordinated Understanding of Semiconductors, users will be able to understand a) the operation of MOSFET devices, b) the limitations of the gradual channel approximation, and c) the limitations of the drift-diffusion model.

The specific objectives of the MOSFET Lab are:

- **Physical Model**: Introduce the concept of:
  - Unipolar devices and transistor action
  - Gradual channel approximation
  - Better modeling of MOSFETs at the nano-scale

- **Mathematical Model**: Apply the drift-diffusion model in PADRE for calculating:
  - MOSFET potential energy profiles, charge densities, electric fields
  - MOSFET transfer and output characteristics
  - Velocity saturation and velocity overshoot effect
  - Transistor breakdown due to impact ionization

- **Computational Model**: Validate MOSFET Lab by running the examples provided

**Recommended Reading**

Users who are new to the operation and modeling of MOSFET devices should consult the following resources:


**Demo**

MOSFet: First-Time User Guide

MOSFet Demonstration: MOSFET Device Simulation and Analysis

**Theoretical Descriptions**

* Tutorial_PADRE_Simulation_Tools.pdf (tutorial)

* Lecture 3A: The Ballistic MOSFET

* Lecture 3B: The Ballistic MOSFET

* MOSFET Operation Description

* Physics of Nanoscale MOSFETs

**Tool Verification**

Verification of the Validity of the MOSFET Tool

**Examples**

MOSFET Worked out problems 1

**Exercises and Homework Assignments**

1. MOSFET - Theoretical Exercises

2. MOSFET Exercise

3. Exercise for MOSFET Lab: DIBL Effect

4. Exercise for MOSFET Lab: Long Channel vs. Short Channel Device

5. MOSfet Homework Assignment - Role of Dielectric Constant and Thickness
6. Exercise for MOSFET Lab: Device Scaling

Solutions to Exercises

Work in progress!

Evaluation

This test will assess users’ conceptual understanding of the physical, mathematical and computational knowledge related to operation of MOSFET devices.

ABACUS: Test for MOSFET Tool

Challenge

In this final challenge users will integrate what they have learned about the operation of MOSFET devices.

MOSFET Lab - Scaling