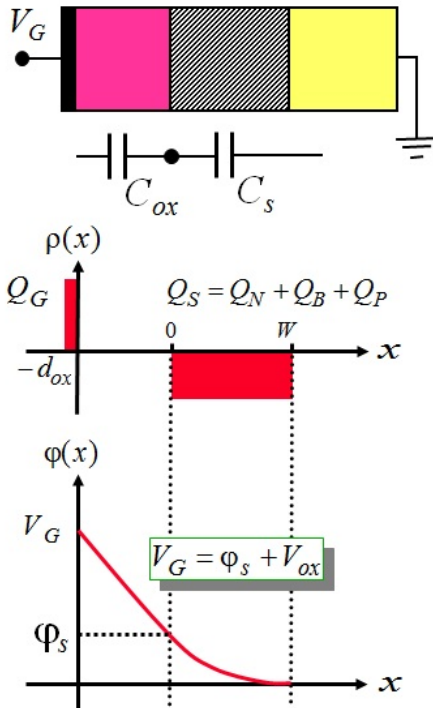# SCHRED Learning Materials

By completing the Schred tool exercises and tests, users will be able to: a) understand the operation of MOS capacitors. b) the concept of bound states in a MOS capacitor structure, c) the meaning of the eigenvalues and the eigenvectors, and d) the form of the eigenvalues and the eigenvectors for triangular confinement as ut occurs in MOS capacitors under inversion conditions.

The specific objectives of the Schred Lab are:

Physical Model	Mathematical Model	Computational Model
a) Introduce the concept of: - Quantum Confinement - Eigenfunctions and Eigenvalues - 1D Schrödinger Equation for Silicon and GaAs MOS Capacitors	b) Apply Mathematical techniques for calculating: - Eigenfunctions and Eigenvalues	
c) Validate Bound States Calculation in a MOS capacitor by running the examples provided for the Schred Tool		

Recommended Reading

Users who are new to the concept of classical and quantum-mechanical description of inversion charge in MOS capacitors, the concept of bound states and solution of the Schrodinger equation for bound states should consult the following resources:

1. D. K. Ferry, Quantum Mechanics: An Introduction for Device Physicists and Electrical Engineers, Taylor & Francis.

2. Rober F. Pierret. (1996). Semiconductor Device Fundamentals. 2nd ed. Reading, MA: Addison-Wesley.

3. D. Vasileska, S. M. Goodnick and G. Klimeck, Computational Electronics: Semiclassical and Quantum Transport Modeling, Morgan & Claypool, June 2010.

Theoretical descriptions

* [Introduction to Schred](#)

* [Quantum Size Effects and the Need for Schred](#)

* [Schred Tutorial Version 2.1](#)

* [How Quantum-Mechanical Space-Quantization is Implemented in Schred, Drift-Diffusion (SILVACO ATLAS) and Particle-Based Device Simulators (Quamc2D)](#)

* [Modeling Single and Dual-Gate Capacitors using SCHRED](#)

* [Schred Source Code Download](#) (source code download)

Exercises and Homework Assignments

1. [Schred: Exercise 1](#)

2. [SCHRED: Exercise 2](#)

3. [Schred: Exercise 3](#)

4. [AQME: SCHRED Assignment – Quantum Confinement](#)

5. [SCHRED Exercise: MOS Capacitor Analysis](#)

Solutions to Exercises

Solutions are provided only to instructors!

Evaluation

This test will assess the users conceptual understanding of the physical, mathematical and computational knowledge related to understanding the concept of MOS capacitors, the semiclassical and the quantum-mechanical charge model and how it affects the total gate capacitance.

[Test for SCHRED](#)

Challenge

Users are challenged to integrate what they have learned about Schred and semi-classical and quantum-mechanical charge model.

[Schred: Solve a Challenge](#)