# SCHRED Exercises

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1. SCHRED solves self-consistently the 1D Poisson equation coupled with the 1D Schrödinger equation, for the purpose of electrostatic modeling of MOS capatitors. This exercise will help you to become familiar with SCHRED. You are required to model a MOS capacitor with oxide thickness $t_{ox}$=4 nm and the following two values of the substrate doping: $N_A=10^{16}$ cm$^{-3}$ and $N_A=10^{18}$ cm$^{-3}$. Use metal gates and T=300 K. Assume complete ionization of the impurity atoms. The applied bias on the gate equals to $V_G$=1 V. For each of the subsrate doping densities use both semiclassical and quantum-mechanical charge description (use 5 as maximum number of subbands for each subband ladder corresponding to either $\Delta_2$ or $\Delta_4$ band) of the electron density in the triangular potential well. For each simulation run, plot the following:

    (a) Conduction band profile and the electron density.

    (b) When using quantum-mechanical charge description, plot the wavefunctions that correspond to the bound states in the triangular potential well.

    Also answer the following questions:

    (c) How does the energy separation between the bound states in the well varies with doping. Why?

    (d) Explain the differences in the electron density distributions obtained by using the semiclassical and quantum-mechanical model.

    (e) How does the average distance of the carriers from the interface changes when we use quantum-mechanical charge description rather than semiclassical (Maxwell-Boltzmann statistics). What implications will this parameter have on MOSFET operation? (You do not need to answer the last portion of this question if you do not have the required background in semiconductor devices).