Homework #6

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Benchmark with results for the general Poisson equation

Analytic results: $\vec{E_s}|_x = \sqrt{\frac{2K_bTN_a^-}{\epsilon_{\text{silicon}}}}\left\{\left(e^{-\frac{q_0\phi_d}{K_bT}} + \frac{q_0\phi_d}{K_bT} - 1\right) + \left(\frac{n_i}{N_a^-}\right)^2\left(e^{\frac{q_0\phi_d}{K_bT}} - \frac{q_0\phi_d}{K_bT} - 1\right)\right\}^{\frac{1}{2}}$ where $\phi_d = \phi_s - \phi_N$, ϕ_s is the external potential at the oxide surface and ϕ_N is the potential at the silicon juction with satisfying the charge neutrality condition.

Numerical results: $-\nabla\phi|_x \simeq -\frac{\phi_2 - \phi_1}{x_2 - x_1}$, where $\phi_1 = \phi_s$.

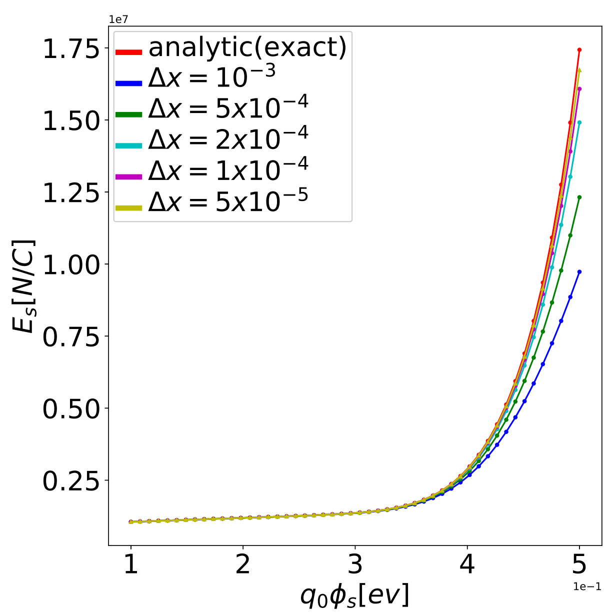

Figure 1: Comparison between the analytic results and numerical results for the general Poisson equation in the metal oxide silicon(MOS) structure

Results for the Eigensolver embedded with the potential $\phi(x)$

case1.

$T_{\mathrm{si}} = 1\mu m$, $\phi_s = 10^{-2}$ev, $\phi_N = -0.287$ev, $N_a^- = 10^{15}\mathrm{cm}^{-3}$, $\Delta x = 10^{-3}\mu m$

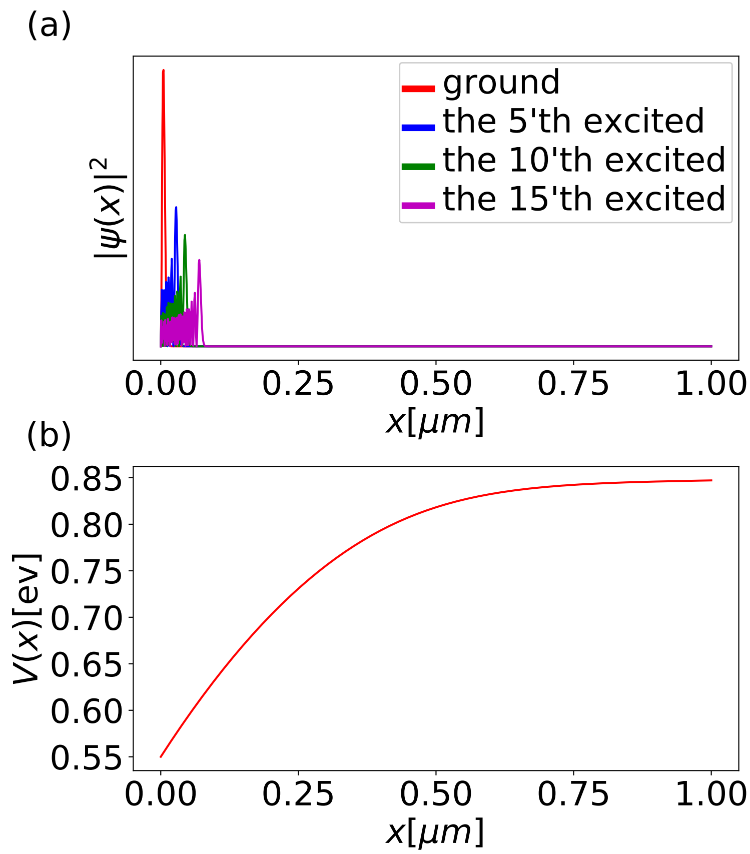

Figure 2: The wave funtions and the given potential $V(x)$ where $V(x) = -q\phi(x) + E_c - E_i$

case2.

$T_{\mathrm{si}} = 1\mu m$, $\phi_s = -0.28\mathrm{ev}$, $\phi_N = -0.287\mathrm{ev}$, $N_a^- = 10^{15}\mathrm{cm}^{-3}$, $\Delta x = 10^{-3}\mu m$

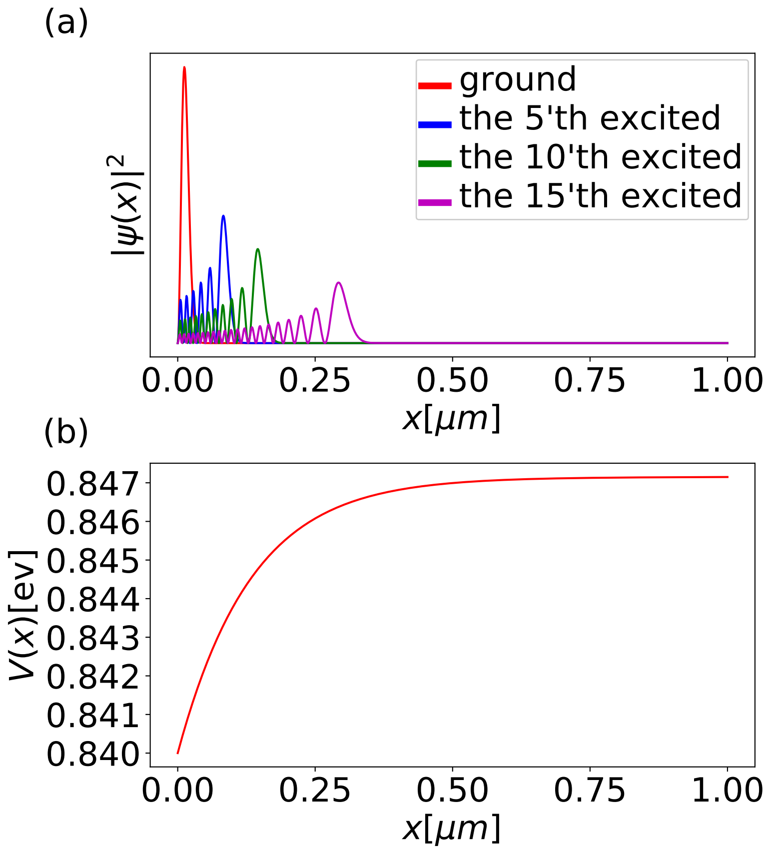

Figure 3: The wave funtions and the given potential $V(x)$ where $V(x) = -q\phi(x) + E_c - E_i$