PHYS 314
Problem set # 4 *(due February 25)*
Each problem is 10 points, unless stated otherwise.

Griffiths: 7.15, 9.5

Q1 A particle of mass m and positive charge q, moving in one dimension, is subject to a uniform electric field $E(x) = E_0$ for $x > 0$ and $E(x) = -E_0$ for $x < 0$, as shown. Consider a trial wave function $\psi(x) \propto e^{-\alpha|x|}$ and estimate the ground-state energy by minimizing the expectation value of the energy.

Q2 In calculations of the molecular spectra one can encounter the following potential: $U(x) = U_0\left(e^{-2\alpha x} - 2e^{-\alpha x}\right)$. With the trial function of your own devising, estimate the ground state energy of such a molecule, assuming $U_0 = \alpha^2\hbar^2/2m$. To receive full credit please explain why you chose the particular trial wave function. As long as your choice is reasonable, the closeness of your estimate to the actual answer will not affect the grade. However, I will provide some candy prize for a person or persons with the most accurate estimate.

Q3 A particle with charge q and mass m is in ground energy state inside a one-dimensional infinite square well with width $2L$, centered at $x = 0$.
(a) Consider a weak uniform electric field E_0 that acts on the particle. What is the probability of finding the particle in the first excited state?
(b) Consider now the case of a time-dependent electric field $E(t) = E_0 e^{-t/\tau}$ that is turned on at $t = 0$ (i.e., no electric field at $t < 0$). Calculate the transition probability from the ground state of the system to the first excited state in the first-order time-dependent perturbation theory for times $t \gg \tau$.