Homework 3: The time-independent Schrodinger equation (**Due Friday September 28**)

September 21, 2018

1 BRUTE FORCE CALCULATIONS **(35 POINTS)**

Do problem 1.17 in Griffiths? book.

2 ONE-DIMENSIONAL QUANTUM DOTS **(35 POINTS)**

Quantum dots are nano-technological devices that can be used to confine the electrons and control their motion. An electron is confined to move in a one dimensional quantum dot. The dot can be modeled with the potential

$$V(x) = \begin{cases} 0 & 0 < x < L \\ \infty & \text{elsewhere} \end{cases} \tag{2.1}$$

1. (**5 points)** The wave function of an electron at time $t = 0$ is given by

$$\Psi(x, t = 0) = Ax^2(L - x)\,. \tag{2.2}$$

   Find the value of A.

2. (**15 points**) Given the electron's initial wave function $\Psi(x, t = 0)$, **Compute** the expectation value of the electron's total energy $\langle \hat{E} \rangle$.

3. (**15 points**) **Calculate** Δ_p and Δ_x and **show** that $\Delta_p \Delta_x$ satisfies the Heisenberg uncertainty principle.

3 QUANTUM ROTOR (**30 POINTS**)

1. **Find** the expression of the total energy of a classical rotor. Your expression should be given in terms of the moment of inertia.
2. Using the substitution $p \rightarrow \hat{p} = -i\hbar\partial/\partial\theta$ **find** the quantum mechanical Hamiltonian.
3. Solve the Schrodinger equation with appropriate boundary conditions and **obtain** the energy levels.