Name:

Student Number:

Quiz 1 ELEC 4705

Tuesday Oct. 4 2010

1. The following four equations are from classical physics.(5 marks)

$$\nabla . E = \rho/\varepsilon_0 \tag{1}$$

$$\nabla . B = 0 \tag{2}$$

$$\nabla \times E = -\frac{\partial B}{\partial t} \tag{3}$$

$$c^2 \nabla \times B = \frac{\partial E}{\partial t} + \frac{j}{\varepsilon_0} \tag{4}$$

   (a) What are they called?

   (b) What physics do they describe? What are E and B?

   (c) Describe the mathematical relationships in two of the equations.

   - **Maxwell's equations.**
   - **The time evolution and spacial distribution of the electromagnetic filed E and B.**
   - **Relationships:**
     - **The source of an electrical field is the existence of electrical charge i.e. flux of E through a closed surface $\propto$ charge inside.**

$$\nabla . E = \rho/\varepsilon_0 \tag{5}$$

     - **Flux of B through a closed surface = 0, i.e. there is no magnetic monpole.**

$$\nabla . B = 0 \tag{6}$$

     - **According to the Farday's law of induction we have:**

$$\nabla \times E = -\frac{\partial B}{\partial t} \tag{7}$$

       (A changing magnetic field will induces an electric field)
     - **According to Ampere's law a current or a time varing electric field induces a magnetic field as:**

$$c^2 \nabla \times B = \frac{\partial E}{\partial t} + \frac{j}{\varepsilon_0} \tag{8}$$

2. (5 Marks) Quantum Mechanics

   (a) What is the uncertainty principle? Write the equation!

   It is impossible to precisely measure the position and momentum as well as the energy and time of a particle at the same time.

$$\Delta x \cdot \Delta p \geq h \tag{9}$$

   (b) What is $1D$ time independent Schrodinger equation for free space?

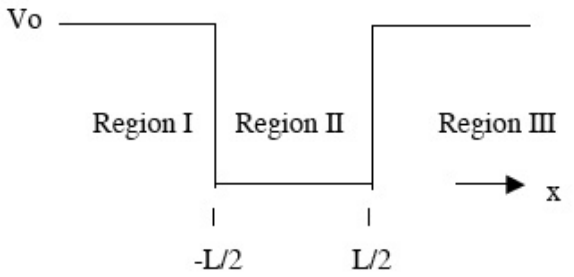
$$\frac{-\hbar^2}{2m}\nabla^2\Psi(x) + V(x)\Psi(x) = E\Psi(x) \tag{10}$$

   (c) What is the Hamiltonian operator(function)? What information does it have about the system?

   The quantum Hamiltonian H is the observable corresponding to the total energy of the system.

$$E = H(r,p) = P^2/2m + V(r) \tag{11}$$

3. (5 marks) For the plot below



(a) Formulate the Schrodinger equation and the form of wave functions for each region.

(b) Formulate the boundary conditions

(c) Formulate the normalization condition.

The solution is in L5.