**CH 107 Tutorial 1**

**Solve these problems BEFORE the tutorial session**

1. Consider the eigenvalue equation  where  is a quantum mechanical operator, and  is an eigenfunction. What are the eigenvalues of the operator?

2. The eigenvalue equation is given as . Suggest eigenfunctions for the following operators

(i)  (ii)  If time permits, try (iii)

3. Plot the following functions and hence, explain which of these CAN NOT be a valid wavefunction. (x is real)

(i)  (ii)  If time permits, try (iii)  (iv) 

4. Under what conditions will a linear combination of two or more eigenfunctions also be an eigenfunction of a quantum mechanical operator?

5. (Important) Suppose that the wavefunction for a system can be written as

where, *, ,*  are orthogonal to each other and are normalized eigenfunctions of the kinetic energy operator,with eigenvalues *E1*, 3*E1* and 7*E1* respectively.

1. Is normalized?
2. What are the possible values that you could obtain in measuring the kinetic energy on the system described by ?
3. What is the (i) average value and (ii) most probable value of kinetic energythat will be obtained for a large number of measurements?

**CH 107 Tutorial 2**

**Solve these problems BEFORE the tutorial session**

1. Calculate the wavelength of light absorbed in the transition from *n* = 1 to *n* = 2 for an electron in a one dimensional box of length of 1.0 nm.

2. For the system described in question 1, evaluate the probability of finding the electron between (i) x = 0.49 and 0.51, (ii) x = 0.24 and 0.26 (x in nm) for *n* = 1 and *n* = 2. Rationalize your answers graphically.

3. Draw the contour plots of the wavefunctions of a quantum mechanical particle in a 2D rectangular box with *L*x = 2*L*y for (*n*x = 3, *n*y = 2) depicting positions of the nodes.

4. Consider a particle in a 2-D box with *L*x = *L*y. How many *distinct* transitions can be possible (*i.e. may be observed*) if you only consider energy levels *ni* = 1,2 (for *I* = x, y)?

5. Let  be an eigenfunction of the Hamiltonian operator (). Often, the relationship = is used. When is this relationship exact? In such condition, evaluate the expression for the total energy of the system.

**Additional Question for students to practice (not to be done during tutorial 2):**

6. The wavefunctions of a particle in a 1D box are orthonormal to each other, i.e., <ψi|ψj>= δij (Kroneker delta). Verify this for *i* = 2, *j* = 1, 2.

Given, .

7. Draw a sketch in which the two wavefunctions in question 6 are overlapped. Using this sketch, verify the orthogonality of wavefunctions.

8. Solve the question in problem 4 considering only levels with *ni* = 1,2,3 (for *i*=x,y)?