Exam.Code:0905
Sub. Code: 33259

2124
B.E., First Semester
ASP-X02: Quantum Physics
(Common with CSE, IT)

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt <u>five</u> questions in all, including Question No. I which is compulsory and selecting two questions from each Part.

x-x-x

I. **Attempt any five parts (2 x 5=10)**

(a) What does Minkowski space mean?
(b) Compute the mass m of an electron having kinetic energy 1.5 MeV.
(c) What is paradoxical in twin paradox?
(d) What is/are Bragg's condition/s for X-ray diffraction?
(e) Why is the Schrödinger equation not valid for relativistic particles?
(f) What is Max Born's interpretation of a wave function?
(g) Why a particle trapped in an infinitely deep potential well can never be at rest?
(h) Why does an intrinsic semiconductor act as an insulator at 0K?

Part A

II. (a) Describe the Michelson-Morley experiment and explain how its negative results were interpreted.
(b) Show that the space time interval is invariant under Lorentz transformations. (6,4)

III. (a) Explain the distribution of energy in black-body spectrum. How far classical theory explains the distribution? How the shortcomings of classical were overcome?
(b) Show that pair production cannot occur in empty space? (6,4)

IV. (a) How does the uncertainty principle explain the finite width of spectral lines?
(b) State the Ehrenfest theorem mathematically and interpret its physical meaning. (4,6)

Part B

V. (a) Show that the energy levels of a one-dimensional quantum harmonic oscillator are quantized and equally spaced, given by the expression:

$$E_n = \left(n + \frac{1}{2}\right)\hbar w$$

where w is the angular frequency of the oscillator and n is the quantum number (n =0,1,2,...).
(b) Find the probability that a particle trapped in a box L wide can be found between 0.45L and 0.55L for the ground and first excited states. (6, 4)

P.T..O.

VI. (a) Write down Schrodinger's equation for a particle in a three dimensional box. Solve it to obtain eigen functions and show that the eigen values are discrete. Explain the meaning of degeneracy of levels.

(b) Give an account of Sommerfeld theory of metals. (6,4)

VII (a) Discuss the periodicity character of potential in a crystal. State and prove Bloch's theorem in this reference.

(b) Show that the effective mass of an electron in a crystal is given by

$$m^* = \frac{\hbar^2}{\frac{d^2E}{dk^2}}$$ (6,4)

x-x-x