Bachelor of Engineering Examination, 2018

(Electrical Engg., 1st Year, 2nd Sem)

Time:- Three hours   PHYSICS-IIB   Full Marks:-100

Answer any **FIVE** questions

1. a) A particle of mass m is confined in a field free region between impenetrable walls at x = 0 and x = a. Find out the stationary energy levels of the particle.

b) Obtain the expression for the normalized wave-function of the particle and represent it graphically. Also show the variation of the probability densities with x for first three values of n.

c) Prove that the wave-functions of the particle are orthogonal.   10+6+4

2. (a) The ground state energy of H-atom is 13.6 eV. Using uncertainty principle estimate the size of the atom.

b) What do you mean by de Broglie waves?

b) Calculate the de Broglie wavelength of the electron in H-atom.

c) Calculate the de Brogle wavelength of a metal ball of mass 10 gm moving with speed 100 cm/s. Will the ball exhibit wave nature in practice ?

d) A particle is incident on a one dimensional potential barrier of height of V_0 and of width d with energy $E < V_0$. Write down the Schrodinger equations for all three regions.

4+3+4+5+4

3. a). What do you mean by microstates and macrostates? Draw the phase-space diagram of a harmonic oscillator. Find the number of phase cells accessible to it in a given energy range.

b) Find the volume in phase-space for a particle with energy E. What is the limiting smallest volume of a phase cell and which principle dictates the limiting value?

(c) State and explain equipartiton theorem in classical statistical mechanics.

8+8+4

4. a) State and explain Heisenberg uncertainty principle. Using this principle show that an electron cannot reside inside a nucleus.

b) Give the physical interpretation of wave function ψ. What is the physical meaning of its normalization?

c) Find the commutator $[x^n, p_x]$.

d) Write down the postulates of quantum mechanics.

8+4+4+4

5. (a) What do you understand by statistical equilibrium? Derive the condition for which an ensemble may be in statistical equilibrium.

b) Write down the Maxwell Boltzmann distribution law. In a system in thermal equilibrium at absolute temperature T, two states with energy difference 4.83×10^{-21} Joule occur with relative probability e^2. Deduce the temperature. ($k = 1.38 \times 10^{-23}$ joule/K)

c) Show that the probability density is not a function of time when the potential is time independent. Is the probability density of finding an electron in the orbital of an atom time-dependent?   8+5+7

6.(a) A sinusoidal emf is applied to a series LCR circuit. Derive an expression for the instantaneous current.

(b) Find the frequencies at which rms current in the circuit and the voltage across the capacitor become maximum.

(c) Find the frequency at which power consumed by the circuit becomes maximum.

                                                                                        10+6+4

7.   (a) Using Maxwell's equations establish the electromagnetic nature of light and estimate the velocity of light in vacuum.

(b) A fully charged capacitor is suddenly connected to a pure inductor in parallel. Discuss both mathematically and graphically how the charge on the capacitor will vary with time.

(c) Find the dimensions of the quantity CR.   10+8+2

8. (a) What do you mean by displacement current? Give its physical significance.

(b) State and prove Poynting's theorem?

(c) Write down Maxwell's electromagnetic equations. Mention the physical laws from which these equations have been derived.   5+10+5