Bachelor of Engineering Examination, 2019(Old)

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

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

Answer any **FIVE** questions

1. (a) What are the characteristics of de Broglie's matter wave?
(b) Explain the physical significance of wave function.
(c) An electron has a speed of 600 m s^{-1} with an accuracy of 0.005 %. Calculate the certainty with which we can locate the position of the electron. h = 6.625×10^{-34} J-s and mass of electron = 9.1×10^{-31} kg.
(d) State and explain the basic postulates of quantum mechanics.
(e) What do you mean by expectation value of a physical dynamical operator? Give one example.
(f) What you understand by orthogonal and normalized wave functions?

3+3+5+3+3+3

2. (a) Write down the expression for energy eigen value of a particle moving inside a box with infinite square well potential. Also obtain the expression for the normalized wave function.
(b) Calculate the expectation value $\langle p_x \rangle$ of the momentum of a particle trapped in a one dimensional box.
(c) Determine the wavelength associated with an electron having kinetic energy equal to 1 MeV.
(d) Does the concept of Bohr orbit violate the Heisenberg's uncertainty principle?
(e) Write down the time independent Schrodinger equation for particle moving in a potential V.

(1+4)+6+4+3+2

3. (a) What are the postulates of classical statistical mechanics?
(b) How do you calculate the number of phase cells in a given energy range of a linear harmonic oscillator?
(c) Establish the Boltzmann relation between entropy and probability.
(d) What do understand by macroscopic and microscopic distribution of a statistical system?

3+4+10+3

4. (a) Explain the postulate of equal a priori probability.
(b) How do you interpret the number of microstates accessible to a macroscopic system?
(c) Use statistical definition of entropy to show that the change in entropy between a state of volume V_i and a state of volume V_f (temperature and number of molecules remaining constant) is equal to $nRlog\frac{V_f}{V_i}$.

(d) Calculate the probability that the speed of oxygen molecule lies between 100 and 101 m/sec at temperature of 200 K.

4+5+8+3

5. (a) Consider an electron of momentum $\vec{p}$ in the Coulomb field of a proton. The total energy is

$$E = \frac{p^2}{2m} - \frac{e^2}{4\pi\epsilon_o r}$$

where r is the distance of the electron from the proton. Assuming that the uncertainty Δr of radial coordinate is $\Delta r \approx r$ and that $\Delta p \approx p$, use Heisenberg's uncertainty principle to obtain an estimate of the size and the energy of the hydrogen atom in the ground state.

(b) Explain what you understand by the terms potential well and potential barrier. How does a particle with energy lower than the barrier height, tunnel through it? Give one example.

(c) Write down Schrodinger equation for a linear harmonic oscillator. In what way is the quantum mechanical description of a simple harmonic oscillator different from classical description?

6+(3+5+1)+(2+3)

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

(b) Find an expression for the power consumed by the circuit.

(c) A steady current of 2 A flows through a coil of self-inductance 30 mH when connected to a 20 V dc supply. Calculate the power dissipation in the coil when reconnected to a 200 V, 50 Hz ac supply.

8+6+6

7. (a) Starting from Maxwell's equations establish the transverse electromagnetic nature of light.

(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 L/R. 10+8+2

8. (a) Write down Maxwell's electromagnetic equations. Mention the physical laws from which these equations have been derived.

(b) Show that Maxwell's equations are consistent with the equation of continuity.

(c) Distinguish between displacement current and conduction current.

(d) What is Poynting vector? Find its dimensions.

8+4+4+4