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END TERM EXAMINATION

SECOND SEMESTER [B.TECH] JUNE-JULY 2023

Paper Code: BS-108 **Subject: Engineering Physics-II**

Time: 3 Hours **Maximum Marks: 75**

Note: Attempt five questions in all including Q.No.1 which is compulsory.

Q1 Answer any five of the following questions: **[5x3=15]**

(a) What is de Broglie hypothesis?

(b) Indicate fundamental differences between the three statistics, namely Maxwell Boltzmann, Fermi Dirac and Bose Einstein Statistical distribution.

(c) Explain Uncertainty Principle

(d) What is specific heat anomaly and how it was solved by Einstein?

(e) Write a short note on the DNA double helix

(f) How band theory of solids helps us to understand the idea of effective mass? Do effective mass of electron and hole change in metal, semiconductor, and insulator?

Q2 a) On the basis of Maxwell's Law of distribution of speed, calculate the average speed and r.m.s velocity of molecule of a perfect gas. **[5]**

b) Show that at high temperature regime, both Bose-Einstein and Fermi-Dirac distribution can be approximated by Maxwell-Boltzmann distribution. **[5]**

c) Verify that the most probable speed of an ideal gas molecule is $\sqrt{2KT/m}$ **[5]**

Q3 a) What is ultraviolet catastrophe? How Plank solved this problem? **[5]**

b) A cubic meter of atomic H at 0 °C and atmospheric pressure contains about 2.7×10^{27} H atoms. Find how many are in their first excited state, n=2. **[5]**

c) Show that if a gas follows the Maxwell-Boltzmann distribution statistics, then the average energy per molecule is $\bar{\epsilon} = \frac{3}{2} KT$, the same you get from elementary kinetic theory of gas. **[5]**

Q4 a) Show graphically how the Fermi-Dirac distribution changes with increasing temperature. Explain your answer in terms of Fermi energy. What is Debye T^3 law? **[5]**

b) Show that in a metal, the contribution of free electron for Specific heat is not too much. **[5]**

c) Find the rms speed of oxygen molecules at 0 °C. The atomic mass of O is 16 u (1 u = 1 atomic mass unit = 1.66×10^{-27} kg). **[5]**

Q5 a) Describe the Davisson-Germer experiment with schematic diagrams and explain how it provides evidence for the wave nature of matter. **[6]**

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b) Write down the postulates of quantum mechanics and discuss the physical significance of wave function and probability current density. [6]

c) Find out the maximum kinetic energy of photoelectrons emitted when ultraviolet light of wavelength 300 nm and intensity 0.1 W/m^2 is directed at a sodium surface (work function = 2.3 eV). [3]

Q6 a) Write down Schrodinger's time dependent equation in its general form and explain all the terms. Justify why Schrodinger's time dependent equation can be arrived at but cannot be derived. [5]

b) What is expectation value and state how to extract information from a wave function. [5]

c) Find the probability that a particle trapped in a box L wide can be found between 0.45 L and 0.55 L for the ground state and first excited state. [5]

Q7 a) Distinguish between intrinsic and extrinsic semiconductors. Indicate on an energy level diagram the conduction and valence bands, donor and acceptor levels. What are the positions of Fermi levels for an intrinsic semiconductor, a n-type semiconductor and a p-type semiconductor? [7]

b) Explain the origin of energy bands in solids. Briefly discuss the Kronig-Penney model. [8]

Q8 a) What are Brillouin zones? Schematically illustrate the first and second Brillouin zones for a two dimensional square lattice. [6]

b) Explain the working of a p-n junction in forward and reverse biasing conditions using schematic diagrams. [6]

c) Draw the V-I characteristics of a tunnel diode and mention its applications. [3]

Q9 Write short notes on **any three** [5x3=15]

a) Photoelectric effect

b) Dulong Petit law and its limitations

c) Reciprocal lattice space

d) X-ray diffraction

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