JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT
TEST -2 EXAMINATION- 2024
BTech-1 Semester (CSE/IT/ECE/CE)

COURSE CODE (CREDITS): 18B11PH211 (3) MAX. MARKS: 25
COURSE NAME: Engineering Physics-II
COURSE INSTRUCTORS: PBB, VSA, SKT, HAZ MAX. TIME: 1.5 Hour

*Note: (a) All questions are compulsory.*
*(b) Marks are indicated against each question in square brackets.*
*(c) The candidate is allowed to make suitable numeric assumptions wherever required for solving problems*

**Q1.** (a) Calculate the de Broglie wavelength associated with a proton moving with a velocity equal to 0.05 times the velocity of light. **[2-marks] [CO-1]**

(b) Draw the graph for wavefunctions $\psi$ and $\psi^2$ for a particle in an infinite potential box of length L. **[3-marks] [CO-2]**

**Q2.** (a) The wavefunction for a quantum particle as a function of position 'y' and time 't' is $A\, e^{-\beta\left[\frac{\alpha y^2}{h}+i\delta t\right]}$, where A, α, β, and δ are real constants. Find the value of A and the expectation value of <y>. **[3-marks] [CO-5]**

(b) Using the uncertainty principle, obtain the radius of Bohr's first orbit. **[3-marks] [CO-1]**

**Q3.** (a) Assume the thermodynamic probability for a BE distribution is

$$W = \prod_{i=1}^{k} \frac{(n_i + g_i)!}{n_i!\, g_i!}$$

Derive an expression for the occupation index for the same. **[3-marks][CO-5]**

(b) Consider 4 distinguishable particles and 2-compartments. Discuss the various possible macrostates and microstates of this system. **[3-marks] [CO-4]**

**Q4.** (a) Obtain the conditions when the three statistics (MB, BE, and FD) give the same results. Also elaborate on the case, when they differ. **[3-marks] [CO-4]**

(b) Using classical MB statistics derive the expression for the root mean square speed. **[3-marks][CO-4]**

(c) At T=22K, calculate the most probable speed of the nitrogen molecule. **[2-marks] [CO-2]**

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$h=6.626\times10^{-34}$ Js; $m=9.1\times10^{-31}$ kg; $c=3\times10^{8}$ m/s; $e=1.6\times10^{-19}$ C; $\int_0^\infty e^{-ax^2}dx = \frac{1}{2}\sqrt{\frac{\pi}{a}}$; $\int_0^\infty x^4 e^{-ax^2}dx = \frac{3}{8a^2}\sqrt{\frac{\pi}{a}}$; k = $1.38\times10^{-23}$ J/K; 1 amu = 1.67377 x $10^{-27}$ kilograms; $m_p$ = 1.67377 x $10^{-27}$ kilograms