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06PHY12/22

First/Second Semester B.E. Degree Examination, June/July 2013

Engineering Physics

Time: 3 hrs. Max. Marks:100

Note: 1. *Answer any FIVE full questions, choosing at least two from each part.*
2. *Answer all objective type questions only on OMR sheet page 5 of the answer booklet.*
3. *Answer to objective type questions on sheets other than OMR will not be valued.*
4. *Physical constants: Electron mass, $m = 9.11\times10^{-31}$kg, Electron charge; $e = 1.6\times10^{-19}$C; speed of light, $C = 3\times10^{8}ms^{-1}$, Planck's constant, $h = 6.63\times10^{-34}$J.S; Avogadro constant = 6.023×10^{23}/g.mol, Permitivity of free space, $\epsilon_0 = 8.85\times10^{-12}$F/m; Botlzmann constant, $k = 1.38\times10^{-23}$ J/k.*

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Choose the correct answer: **(04 Marks)**

i) Rayleigh-Jeans law predicts the fall of intensity of the radiation towards.
A) Shorter wavelength side B) Longer wavelength side
C) Independent of wavelength D) None of these

ii) If the velocity of the particle is doubled, then the de-Broglie wavelength associated with it becomes.
A) Twice B) Four times C) Half D) No change

iii) The phase velocity of the matter wave is given by
A) $V_{phase} = C^2 \times V_{group}$ B) $V_{phase} = C^2 + V_{group}$
C) $V_{phase} = C \times V_{group}$ D) $V_{phase} = C^2/V_{group}$

iv) The de-Broglie wavelength associated with 400gm cricket ball with a speed of 90km/hr is
A) 6.63×10^{-35}m B) 3.32×10^{-35}m C) 6.63×10^{-32}m D) 9×10^{-35}m

b. Describe the Rayleigh-Jeans law and ultraviolet catastrophe. **(04 Marks)**

c. Explain phase velocity, group velocity and particle velocity. Deduce an expression for de-Broglie wavelength in terms of group velocity. **(08 Marks)**

d. A fast moving particle of mass 1.675×10^{-27}kg is found to have an associated de-Broglie wavelength 2×10^{-12}m. Find its kinetic energy, phase velocity and group velocity. **(04 Marks)**

2 a. Choose the correct answer: **(04 Marks)**

i) The product of uncertainties involved in a simultaneous measurement of angular displacement and angular momentum is:
A) $\leq \hbar/2$ B) $\geq \hbar/2$ C) $\hbar$ D) $\hbar/2\pi$

ii) The wave equation for a de-Broglie wave traveling along positive x-direction in complex notation
A) $\psi = Ae^{-i(kx-wt)}$ B) $\psi = Ae^{(kx-wt)}$ C) $\psi = Ae^{(kx-iwt)}$ D) $\psi = Ae^{-i(kx+wt)}$

iii) A wave function is acceptable wave function if it is
A) Infinite everywhere B) Multiple value everywhere
C) Continuous everywhere D) None of these

iv) The zero point energy of an electron in an infinite potential well is given by
A) $\frac{h^2}{8\pi ma^2}$ B) $\frac{n^2h^2}{8ma}$ C) $\frac{n^2h^2}{8ma^2}$ D) $\frac{h^2}{8ma^2}$

b. What is a wave function? Give its physical significance and properties. **(04 Marks)**

c. Assuming the time independent Schrodinger wave equation, discuss the solution for energy of a particle in one dimensional infinite potential well. **(08 Marks)**

2 d. In a measurement that involved a maximum uncertainity of 0.012%, the speed of an electron was found to be 800 ms^{-1}. Calculate the corresponding uncertainty involved in determining its position. **(04 Marks)**

3 a. Choose the correct answer: **(04 Marks)**

i) According to classical free electron theory, the valence electrons are treated as
A) Liquid molecules B) Gas molecules C) Fixed particles D) None of these

ii) If V_d is the magnitude of drift velocity acquired by the electrons in presence of the applied electric field E, then mobility is defined as:
A) $V_d.E$ B) $V_d.E^2$ C) V_d/E D) V_d/E^2

iii) Fermi level is that energy level, above which, all the energy levels are
A) Filled at 0K B) Empty at 0K
C) Partially filled at 0K D) None of these

iv) The Fermi level of a metal is 2.1 eV. The energy for which the probability of occupancy, 0.5 at 300K is
A) 1.1 eV B) 4.2 eV C) 2.1 eV D) 3.15 eV

b. How does electrical resistance of a conductor change with impurity and temperature? **(04 Marks)**

c. Explain energy density of states and derive an expression for number of allowed energy states for a unit volume of a solid. **(08 Marks)**

d. Calculate the free electron concentration and hence the mobility of electrons in aluminium metal assuming that each of its atom contributes three free electrons for conduction. Given, for aluminum, resistivity = 2.7×10^{-8} Ω.m, atomic weight = 26.98 and density = 2.7×10^{3} kg/m^3. **(04 Marks)**

4 a. Choose the correct answer: **(04 Marks)**

i) Orientational polarization
A) Increases with temperature B) Decreases with temperature
C) Independent of temperature D) None of these

ii) The dielectric loss is the loss of energy in the form of
A) Heat B) Light C) X-rays D) Radio waves

iii) In piezoelectric crystals, when pressure is applied
A) Crystal ions shift their positions B) Atoms do not shift their position
C) Ion exchange occurs D) Distortion of atoms occurs

iv) Hard magnetic materials are characterized by
A) Low hysteresis energy loss B)High hysteresis energy loss
C) Low eddy current loss D) Low coercivity

b. What are ferroelectric materials? What are their properties and applications? **(04 Marks)**

c. What is internal field? Derive an expression for the internal field for a linear array of atoms in a dielectric. **(08 Marks)**

d. An elemental solid dielectric material has a polarizability 7×10^{-40} Fm^2. Assuming the internal field to be Lorentz field, calculate the dielectric constant for the material if it has 3×10^{28} $atoms/m^3$. **(04 Marks)**

PART – B

5 a. Choose the correct answer: **(04 Marks)**

i) Laser action is achieved by creating
A) Induced absorption B) Population inversion
C) Thermal equilibrium D) Resonance cavity

5 a. ii) Brewster Window is used in a laser system to obtain
A) Plane polarized laser B) Circularly polarized laser
C) High intensity laser D) None of these
iii) Semiconductor laser is one in which the active medium is
A) Direct band gap semiconductor B) Indirect band gap semiconductor
C) Conductor D) Insulator
iv) Holography is the technique of capturing pictorial details by using the phenomenon,
A) Reflection B) Refraction C) Interference D) Polarization

b. Explain the necessary conditions required for obtaining laser beam. **(04 Marks)**

c. Describe with energy level diagram, the construction and working of Helium-Neon laser. **(08 Marks)**

d. A pulsed laser emits photons of wavelength 780nm with 20mW average power/pulse. Calculate the number of photons contained in each pulse if the pulse duration is 10ns. **(04 Marks)**

6 a. Choose the correct answer: **(04 Marks)**
i) The expulsion of the magnetic flux from the body of the superconducting material is called
A) Josephson effect B) Meissner effect
C) Critical magnetic field D) None of these
ii) The quantum of magnetic flux used in SQUIDS is
A) h/2e B) 2h/e C) 2πh/e D) e/2πh
iii) In optical fibers, the refractive index of core is
A) Lower than cladding B) Higher than cladding
C) Equal to that of cladding D) None of these
iv) The loss of intensity of light with distance traveled is given by
A) Lambert's law B) Snell's law C) Rayleigh's law D) Newton's law

b. Explain BCS theory of superconductivity. **(04 Marks)**

c. With neat diagrams, explain the different types of optical fibers. **(08 Marks)**

d. Calculate the V-number and the number of modes the fiber supports if its core radius is 20μm. Refractive indices of core and cladding are 1.55 and 1.5 respectively. The wavelength of the propagation wave is 1400nm. **(04 Marks)**

7 a. Choose the correct answer: **(04 Marks)**
i) A crystal of tetragonal lattice has a unit cell with sides
A) $a = b = c$ B) $a = b \neq c$ C) $a \neq b \neq c$ D) $a > b > c$
ii) The coordination number for an atom in bcc structure: A) 12 B) 9 C) 8 D) 6
iii) The relation between the atomic radius and the lattice constant in FCC structure is

A) $R = \frac{a}{2\sqrt{2}}$ B) $R = \frac{\sqrt{3}a}{4}$ C) $R = \frac{\sqrt{3}a}{2}$ D) $R = \frac{a}{2}$

iv) Which of the following condition is Bragg's law?
A) $d \sin\theta = n\lambda$ B) $\sin\theta = dn\lambda$ C) $d^2\sin\theta = n\lambda$ D) $2d\sin\theta = n\lambda$

b. Explain the procedure followed to specify the crystal planes using miller indices with an example. **(04 Marks)**

c. Describe the construction and working of Bragg's x-ray spectrometer and explain how it is used to determine the interplanar spacing in a crystal. **(08 Marks)**

d. X-rays of wavelength 0.72 A° are diffracted in the first order from (110) plane of a calcite crystal. If the glancing angle is 9.6°, calculate the lattice constant of the crystal. **(04 Marks)**

8 a. Choose the correct answer: **(04 Marks)**

i) The state of matter around the nanoscale size is referred to as
A) Mesoscopic state B) Quantum state C) Plasma state D) Solid state

ii) Ultrasonic wave are produced by
A) anti-piezoelectric effect B) Piezoelectric effect
C) Electric discharge D) Mechanical vibration

iii) Bulk material reduced in three directions is
A) Mechanical scaling B) Quantum wire
C) Quantum dot D) Reduced structure

iv) Ultrasonics are
A) Mechanical waves B) Non-mechanical waves
C) Relativistic waves D) Electromagnetic waves

b. Describe molecular manufacturing. **(04 Marks)**

c. Describe the experimental method of determining the velocity of ultrasonic waves in a given liquid. **(08 Marks)**

d. What are carbon nano-tubes? Give their properties and applications. **(04 Marks)**

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