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06PHY12/22

First/Second Semester B.E. Degree Examination, June 2012
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 in 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 : h = 6.62 $\times 10^{-34}$ J-s, me = 9.1 $\times 10^{-31}$ kg, C = 3 $\times 10^{8}$ m/s.***

PART – A

1 a. Choose your answers for the following : **(04 Marks)**

i) If the de Broglie wave is represented by a wave group, then
- A) group velocity is equal to velocity of light
- B) group velocity is equal to phase velocity
- C) group velocity is equal to particle velocity
- D) phase velocity is greater than velocity of light.

ii) The Davisson – Germer experiment provides direct verification of
- A) particle nature of the waves
- B) x-ray diffraction through crystals
- C) de Broglie's hypothesis
- D) quantum nature of light

iii) In Black-body radiation spectra
- A) λ_m shifts towards lower wave length side as temperature increases
- B) λ_m shifts towards lower wave length side as temperature decreases
- C) the total area covered by the curve remains same at all temperature
- D) the total energy radiated per second per unit area is equal to cubic power of temperature.

iv) If the energy of an electron is comparable to its rest mass energy, then which of the following energy equation holds good.

A) $E = \sqrt{m_0^2c^4 + p^2c^2}$ B) $E = \frac{p^2}{2m}$

C) $E = pc$ D) $E = \sqrt{m_0c^2 + p^2c^2}$

b. Assuming that de Broglie's wave associated with a particle is represented by a wave group, find a relationship between group velocity and particle velocity. **(05 Marks)**

c. Using the concept of group velocity derive an expression for de Broglie wavelength. **(06 Marks)**

d. Compare the de Broglie wave length associated with
i) 10g bullet travelling at 500 m/s and
ii) An electron with kinetic energy of 100 MeV. **(05 Marks)**

2 a. Choose your answers for the following : **(04 Marks)**

i) According to uncertainty principle, an electron with 1 MeV K.E.
- A) Cannot be accommodated within the nucleus
- B) Can be accommodated with in the nucleus
- C) Cannot be a part neither of atom nor nucleus
- D) Non of the these

ii) The wave function ψ is said to be normalized if

A) $\int_{-\infty}^{+\infty} |\psi|^2 dv$ B) $\int_{-\infty}^{+\infty} |\psi|^2 dv = 0$ C) $\int_{-\infty}^{+\infty} |\psi|^2 dv = \infty$ D) None of these

iii) For a physical system, the Schrodinger's wave equation is Time-independent
A) When potential energy of the system does not depend on time
B) When potential energy of the system depends on time
C) When potential energy of the system depends both on time and position
D) When the total energy of the system is not steady.

iv) For a particle trapped in an infinite potential well, the possible energy Eigen values
A) Vary continuously
B) Are discrete energy states including zero energy state
C) Are discrete energy states excluding zero energy state
D) Non of these.

b. Explain physical significance of wave function. **(05 Marks)**

c. Find the energy eigen values of a particle trapped in a one dimensional potential well of infinite height. **(07 Marks)**

d. Compute the first two permitted energy states of an electron trapped in a box of $1A^o$ unit wide. **(04 Marks)**

3 a. Choose your answers for the following : **(04 Marks)**

i) Relaxation time
A) is the time taken for the drift velocity to decay to 1/e of its initial value when electric field is switched off.
B) is the time taken for drift velocity to increase by a factor 'e' of initial value when the field is switched on
C) is the time duration between two successive collisions
D) is the time taken for the drift velocity to decay to zero of its initial value when electric field is switched off.

ii) The collision time and root mean square velocity of the electron at room temperature are 2.5×10^{-14}s and 1×10^5m/s respectively. The classical value of mean free path of the electron is
A) 2.5×10^{-19} m B) 0.25 nm C) 25 A^o units D) 2.5 nm

iii) Free electron Fermi gas
A) is a gas of free electrons moving zig-zag in a lattice
B) is a gas of interacting electrons moving opposite to applied electric field in a lattice
C) is a gas of free electrons escaping the metal surface
D) is a gas of free and non interacting electrons subject to Pouli's exclusive principle

iv) Fermi energy level is that energy level at which
A) the probability occupation is full B) the probability occupation is half
C) the probability occupation is zero D) None of these

b. Discuss the breakdown of classical free electron theory with specific reference to mean free path of electrons and molar specific heat of metals. **(04 Marks)**

c. Define density of energy states in metals and derive an expression for the density of energy states. **(08 Marks)**

d. Calculate the mobility of free electrons in silver at room temperature, given that, silver has electron density $5.89 \times 10^{+28}/m^3$ and resistivity of 1.61×10^{-8} Ωm. **(04 Marks)**

4 a. Choose your answers for the following : **(04 Marks)**

i) The electronic polarizability α_e of a gas atom is
A) $4\pi\in_o$ B) $4\pi\in_o R$ C) $4\pi\in_o R^2$ D) $4\pi\in_o R^3$

ii) The dipole moment per unit volume of a solid is the sum of all the individual dipole moments and is called
A) Polarization of the solid B) Permitivity of the solid
C) Electrostatic moment D) None of these

iii) In a ferroelectric material, as the applied electric field is gradually reduced to zero, the polarization still left is known as :
A) Coercive polarization B) Remanent polarization
C) Zero polarization D) Positive polarization

iv) The magnetic material in which permanent magnetic dipoles due to electron spin are already aligned in the absence of magnetic field

A) Paramagnetic materials B) Ferromagnetic materials
C) Ferrimagnetic materials D) Diamagnetic materials

b. Explain the term 'internal field'. Derive an expression for internal field in the case of one dimensional array of atoms in dielectric solids. **(07 Marks)**

c. What are hard and soft magnetic materials? Give their characteristic properties? **(06 Marks)**

d. The electronic polarizability of Helium is 0.18×10^{-40} F.m^2. Calculate the radius of the electron orbit ($\in_o = 8.854 \times 10^{-12}$ Fm^{-1}). **(03 Marks)**

PART – B

5 a. Choose your answers for the following : **(04 Marks)**

i) If E_u and E_l are energies of upper and lower energy levels of an atom, then, stimulated emission is

A) a process of emission of a photon of energy $h\gamma = E_u - E_l$
B) a process of emission of a photon of energy $h\gamma = E_u - E_l$ in addition to incident photon
C) a process of absorption of a photon of energy $h\gamma = E_u - E_l$ resulting in excitation
D) is a process of natural decay

ii) At radiative thermal equilibrium

A) upward radiative flux is absent
B) downwards radiative flux is absent
C) upward radiative flux is not equal to downward radiative flux
D) upward radiative flux is equal to downward radiative flux

iii) If N_u and N_l are population densities of upper and lower energy states respectively; then population inversion is the condition such that

A) $N_u = N_l$ B) $N_u < N_l$ C) $N_u > N_l$ D) $\frac{N_u}{N_l} = e^{(E_u - E_l)/KT}$

iv) The principle of construction of hologram is due to

A) Diffraction phenomenon B) Scattering phenomenon
C) Polarization phenomenon D) Interference phenomenon

b. Derive an expression for spectral energy density at thermal equilibrium in terms of Einstein's coefficients. **(08 Marks)**

c. With the help of a neat energy level diagram, describe the construction and working of He – Ne laser. **(08 Marks)**

6 a. Choose your answers for the following : **(04 Marks)**

i) The propagation mechanism in optical fibers is based on the principle of

A) Scattering of light at the boundary between core and cladding
B) Total internal reflection of light at the boundary between core and cladding
C) Dispersion of light in the media of the core
D) None of these

ii) The transmission attenuation in optical fibers in expressed in

A) $\text{dB loss} = \log_{10}\left(\frac{P_{out}}{P_{in}}\right)$ B) $\text{dB loss} = -\log_{10}\left(\frac{P_{out}}{P_{in}}\right)$

C) $\text{dB loss} = -10\ \log_{10}\left(\frac{P_{out}}{P_{in}}\right)$ D) $\text{dB loss} = 10\ \log_{10}\left(\frac{P_{out}}{P_{in}}\right)$

iii) The temperature at which a conductor becomes a super conductor is called

A) Super conducting temperature B) Curi temperature
C) Onne's temperature D) Critical temperature

iv) Type-1 super conducting material when placed in a magnetic field will
A) Attract the magnetic field towards its centre
B) Repel all the magnetic lines of force passing through it
C) Attract the magnetic field but transfer it into a concentrated zone
D) Not influence the magnetic field

b. Explain Meissner effect. **(05 Marks)**

c. Describe different types of optical fibers with neat diagrams. **(06 Marks)**

d. An optical fiber has cladding of refractive index 1.5 and numerical aperture 0.39, find the refractive index of the core and acceptance angle, confinement angle, and critical angle for the boundary between core and cladding. **(05 Marks)**

7 a. Choose your answers for the following : **(04 Marks)**

i) Which of the following crystal structure is having the least coordination number?
A) Simple cubic B) Body centred cubic
C) Face centered cubic D) Diamond structure

ii) In TRIGONAL crystal systems the axial lengths and inter axial angles respectively are
A) $a = b = c$ and $\alpha = \beta = \gamma = 90^o$ B) $a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma$
C) $a = b \neq c$ and $\alpha = \beta = 90^o$, $\gamma = 120^o$ D) $a = b = c$ and $\alpha = \beta = \gamma < 120^o \neq 90^o$

iii) If (hk*l*) are the miller indices of a plane,
A) then, h, k, *l* are intercepts on $\bar{a}, \bar{b}$ and $\bar{c}$ axes respectively
B) then the plane cuts the axes into h, k and *l* equal segments respectively
C) then, h, k, *l* represents three non collinear points on the plane
D) then, they refer to planes which in crystal are equivalent even tough their miller indices differ.

iv) If 'a' is lattice constant, $\Delta\nu$, volume of each atom and 'n' is number of atoms per unit cell, then the atomic packing factor is
A) $\frac{n\Delta\nu}{a^3}$ B) $\frac{na^3}{\Delta\nu}$ C) $\frac{a^3}{n\Delta\nu}$ D) $n.\ \Delta\nu.\ a^3$

b. What do you understand by coordination number and atomic packing factor in crystals? Show that the packing factor for bcc and fcc structures are $\sqrt{3}\frac{\pi}{8}$ and $\sqrt{2}\frac{\pi}{6}$ respectively. **(08 Marks)**

c. Deduce Bragg's law for x-ray diffraction in crystals. **(04 Marks)**

d. Copper has fcc structure and the atomic radius is 0.1278 nm. Calculate the inter planar spacing for (111) and (321) planes. **(04 Marks)**

8 a. Choose your answers for the following : **(04 Marks)**

i) The graphite structure is composed of layers of arranged carbon atoms
A) Octogonally B) Pentoganally C) Hexoganally D) Septoganally

ii) In considering the scaling of electromagnetic systems, it is convenient to assume that, electrostatic field strengths
A) are independent of scale B) are dependent on scale
C) are weak D) are strong

iii) In which of the following media the ultrasonic velocity is fastest
A) Sea water B) Ordinary water C) Distilled water D) Alcohol

iv) Ultrasonic waves are
A) Radio waves with frequency of the order of 10^{10} Hz
B) Transverse waves with frequency of the order of 20000 Hz
C) Longitudinal waves with frequency of the order of 2000 Hz
D) Sound waves with frequency more than 20000 Hz.

b. What is scaling of classical mechanical systems? What are the basic assumptions made in scaling? Give the magnitudes and scaling of four physical parameters. **(08 Marks)**

c. Describe a method of measuring velocity of ultrasonic waves in liquids. **(08 Marks)**

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