First/Second Semester B.E. Degree Examination, December 2011
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 : Electron mass = 9.1×10^{-31}kg; Electron charge e = 1.6×10^{-19}C; Velocity of light = C = 3×10^{8}m/s; Planck's constant h = 6.63×10^{-34}JS; Avogadro number N = 6.025×10^{28}/k mole; Permitivity if vacuum ϵ_0 = 8.85×10^{-12}F/M; k = 1.38×10^{-23}J/k.*

PART – A

1 a. Choose your correct answer for the following :
   i) The de – Broglie wavelength of a particle at rest is

   A) Zero   B) Infinite   C) $\dfrac{h}{p}$ D) $\dfrac{h}{v}$

   ii) The photoelectric effect is observed only if the wavelength of light is
   A) Above the threshold wavelength   B) Zero
   C) Below the threshold wavelength   D) Equal to the threshold wavelength

   iii) Phase velocity v_{phase} is equal to

   A) $\dfrac{c^2}{v_{group}}$ B) $\dfrac{v_{group}}{c^2}$ C) $v_{group}^2 c$ D) $v_{group}^2 c^2$

   iv) According to Wein's law, the wavelength of maximum intensity λ_m is

   A) $\lambda_m \alpha T$ B) $\lambda_m \alpha \dfrac{1}{T}$ C) $\lambda_m \alpha T^4$ D) $\lambda_m \alpha \dfrac{1}{T^4}$

   (04 Marks)

   b. What are matter waves? Explain the Davission – Germer experiment to establish the wave nature of electrons. **(10 Marks)**

   c. Compare the momentum, the total energy and the kinetic energy of an electron with a de – Broglie wavelength of 1 Å, with that of a photon with the same wavelength. **(06 Marks)**

2 a. Choose your correct answer for the following :
   i) According the Heisenberg's uncertainty principle
   A) $\Delta x \cdot \Delta P \geq \hbar / 2$ B) $\Delta x \cdot \Delta P < \hbar / 2$
   C) $\Delta x \cdot \Delta P > \hbar^2$ D) $\Delta x \cdot \Delta P < \hbar^2$

   ii) If the uncertainty in the location of a particle is equal to its de – Broglie wavelength, the uncertainty in its velocity will be
   A) Its velocity   B) Half its velocity
   C) Twice its velocity   D) Four times its velocity

   iii) The normalization of wave function is always possible if $\int\limits_{-\infty}^{\infty}\psi^*\psi dx$ is

   A) Finite   B) Infinite   C) Zero   D) None of these

   iv) Zero point energy of a particle in one dimensional box is E =

   A) $\dfrac{h^2}{8mL^2}$ B) 0   C) $\dfrac{8mL^2}{h^2}$ D) $\dfrac{8m^2L^2}{h^2}$

   (04 Marks)

b. What is wave function? Derive the one – dimensional time independent Schrodinger wave equation for an electron. **(08 Marks)**

c. A wave function is given by $\psi = A \sin [n\pi \, x/L]$ for the motion of a particle in a potential well of breadth L. Calculate the value of A, if x is the position of the particle along L. **(04 Marks)**

d. An electron has a speed of 6×10^5 m/s with an accuracy of 0.01 %. With what accuracy one can locate the position of an electron? **(04 Marks)**

3 a. Choose your correct answer for the following :
   i) In the free electron theory, the electric field due to ion cores is
      A) neglected
      B) not constant
      C) assumed to be constant
      D) None of these
   ii) The expression of electric resistivity ρ is
      A) $\dfrac{ne^2\tau}{m}$
      B) $\dfrac{m}{ne^2\tau}$
      C) $\sqrt{\dfrac{ne^2\tau}{m}}$
      D) $\sqrt{\dfrac{m}{ne^2\tau}}$
   iii) At high temperatures, the mean free path λ, of an electron in a metal is proportional to
      A) $\dfrac{1}{T^2}$
      B) $\dfrac{1}{T}$
      C) T^2
      D) Independent of temperature
   iv) Mobility M of an electron is
      A) $\dfrac{E}{v_d}$
      B) $\dfrac{v_d}{E}$
      C) $\dfrac{E^2}{v_d}$
      D) $\dfrac{v_d^2}{E}$ **(04 Marks)**

b. State the Matthiessen's rule. How does the electrical resistance of a metal change with impurity and temperature? **(06 Marks)**

c. Explain any three merits of quantum free electron theory of metals. **(06 Marks)**

d. Find the relaxation time of conduction electrons in a metal of resistivity 1.587×10^{-8} Ωm, if the metal has 5.85×10^{28} conduction electrons per m^3. **(04 Marks)**

4 a. Choose your correct answer for the following :
   i) The electric dipole moment per unit volume is
      A) Magnetization
      B) Dipole moment
      C) Electric polarization
      D) Electric susceptibility
   ii) If the distance between the plates of a parallel plate capacitor is doubled, the capacitance is
      A) Doubled
      B) Halved
      C) Increased four times
      D) Decreased four times
   iii) The magnetic dipole moment if measured in units of
      A) Wb m^2
      B) Wb/m^2
      C) Am^2
      D) A/m
   iv) Some crystalline solids exhibit electric polarization, when strained elastically. This is known as
      A) ferroelectric effect
      B) hysteresis
      C) piezoelectric effect
      D) loss angle **(04 Marks)**

b. Describe different mechanisms of electrical polarization. **(08 Marks)**

c. Write a note on Ferrites. **(04 Marks)**

d. What is the polarization produced in sodium chloride by an electric field of 600 V/mm if it has a dielectric constant of 6? **(04 Marks)**

PART – B

5 a. Choose your correct answer for the following :

i) The rate of stimulated emission is

A) Independent of the number of atoms in the exited state.

B) Directly proportional to the energy density of the incident radiation.

C) Inversely proportional to the energy density.

D) None of the above.

ii) The lifetime of the metastable is about _____ sec

A) 10^{-3} B) 10^{-13} C) 10^{2} D) 10^{-9}

iii) Two photons are coherent when

A) They travel at the same speed   B) Their phases are different

C) Their wavelengths are the same   D) They obey Planck's equation

iv) The lasers that are used in holography are _____ lasers

A) Solid state   B) Argon pulsed

C) Semiconductor   D) He – Ne **(04 Marks)**

b. Discuss the three possible ways through which radiation interacts with the matter. **(06 Marks)**

c. What is holography? Explain the construction of a hologram. **(06 Marks)**

d. A He – Ne laser is emitting a laser beam with an average power of 4.5 MW. Find the number of photons emitted per second by the laser. The wavelength of the emitted radiation is $6328 \overset{\circ}{A}$. **(04 Marks)**

6 a. Choose your correct answer for the following :

i) In a superconductor, critical magnetic field

A) increases, if the temperature decreases

B) does not depend on the temperature

C) increases, if the temperature increases

D) remains constant

ii) When the electrons flows in the form of cooper pairs in materials

A) they do not encounter any scattering

B) the resistance factor vanishes

C) the conductivity becomes infinity

D) All the above

iii) Propagation of light through optical fiber is because of

A) Reflection   B) Polarization

C) Interference   D) Total internal reflection

iv) The mechanisms through which attenuation takes place in optical fiber are

A) absorption loss   B) Scattering loss

C) radiation loss   D) All of these **(04 Marks)**

b. Obtain an expression for the numerical aperture in an optical fiber. **(06 Marks)**

c. Distinguish between type I and type II superconductors. **(06 Marks)**

d. The attenuation of light in an optical fiber is 3.6 dB/km. What fractional initial intensity remains after 1 km? **(04 Marks)**

7 a. Choose your correct answer for the following :
   i) A unit cell contains
      A) One lattice point   B) Two lattice points
      C) Four lattice points   D) Three lattice points
   ii) The miller indices of the plane parallel to the X and Y axes are
      A) (100)   B) (010)   C) (111)   D) (001)
   iii) The coordination number of BCC structure is
      A) 6   B) 8   C) 2   D) 4
   iv) Interplanar spacings of a cubic system d_{hkl} is equal to

   A) $\dfrac{a}{\sqrt{h^2+k^2+l^2}}$ B) $\dfrac{a^3}{\sqrt{h^2+k^2+l^2}}$ C) $\left(\dfrac{a}{\sqrt{h^2+k^2+l^2}}\right)^3$ D) $\dfrac{a^2}{\sqrt{h^2+k^2+l^2}}$

   (04 Marks)
   b. Derive Bragg's law for x-ray diffraction in crystals. **(04 Marks)**
   c. Define atomic packing factor. Calculate the packing factor for SC and BCC structures.
   (08 Marks)

   d. Calculate the density of diamond, given that the cube edge of its unit cell is 3.57 Å and the atomic weight of carbon is 12.01. **(04 Marks)**

8 a. Choose your correct answer for the following :
   i) The physics of nanotechnology is also called as
      A) Plasma physics   B) Nuclear physics
      C) Mesoscopic physics   D) All the above.
   ii) Quantum structure in 2 dim is called
      A) wire   B) DOT
      C) Film   D) Cluster
   iii) Nonotubes are
      A) Strong   B) Non – reactive
      C) Withstand high temperature   D) All the above
   iv) The production of ultrasonics is based on the principle of
      A) Photoelectricity   B) Peizoelectricity
      C) Compton effect   D) Thermionic emission   **(04 Marks)**
   b. What are smart materials? Explain the properties of smart materials. **(08 Marks)**
   c. What is non – destructive testing? Explain with principle, how the flow in a solid can be detected by a non – destructive method using ultrasonics. **(08 Marks)**

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