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10PHY12/22

# First/Second Semester B.E. Degree Examination, January 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 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 : Velocity of light, $c = 3 \times 10^8$ m/s, Plank's constant, $h = 6.625 \times 10^{-34}$ JS, Electron charge, $e = 1.602 \times 10^{-19}$ C, Mass of Electron, $m = 9.11 \times 10^{-31}$ kg, Avogadro number, $N_A = 6.02 \times 10^{26}$/Kmole, Permitivity of vacuum $\epsilon_0 = 8.85 \times 10^{-12}$ F/m, Boltzmann constant, $K = 1.38 \times 10^{-23}$ J/K.*

## PART – A

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

i) The law which failed to account for shorter wavelength region of black body radiation spectrum is,
A) Wein's law B) Rayleigh-Jean's law C) Planck's law D) Maxwell's law

ii) The de-Broglie wavelength of a particle at rest is
A) Zero B) infinite C) h/p D) h/v

iii) If group velocity of particle is $4.7 \times 10^6$ m/s then its phase velocity is,
A) $6 \times 10^6$ m/s B) $4.7 \times 10^6$ m/s C) $9.4 \times 10^6$ m/s D) $1.91 \times 10^{10}$ m/s

iv) The particle velocity of wave is equal to,
A) group velocity B) phase velocity C) velocity of light D) velocity of sound

b. Describe Davisson and Germer experiment for confirmation of de-Broglie hypothesis. **(07 Marks)**

c. Derive de-Broglie wavelength using group velocity. **(05 Marks)**

d. Calculate the de-Broglie wavelength of particle of mass 0.65 MeV/$C^2$ has a kinetic energy 80 eV. **(04 Marks)**

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

i) In quantum mechanics the energy operation is represented as:
A) $\frac{8\pi^2 m}{h^2}\frac{\partial^2}{\partial x^2}$ B) $-\frac{h^2}{4\pi^2 m}\frac{\partial^2}{\partial x^2}$ C) $-\frac{h^2}{8\pi^2 m}\frac{\partial^2}{\partial x^2}$ D) $\frac{h^2}{2\pi^2 m}\frac{\partial^2}{\partial x^2}$

ii) The probability of finding the particle within an element of volume $d\tau$ is,
A) zero B) $\int|\psi|^2 d\tau$ C) $\int|\psi|d\tau$ D) $\int|\psi^*|d\tau$

iii) If an electron moves in one dimensional box of length 2 nm, the normalization constant is,
A) $1(nm)^{-1/2}$ B) $2(nm)^{-1}$ C) $\sqrt{2}(nm)^{-1}$ D) zero

iv) The energy of a particle $E_n$ in one-dimensional potential box of width L and infinite height is,
A) $nh / 8mL^2$ B) $nh / 8mL$ C) $n^2h^2 / mL^2$ D) $n^2h^2 / 8mL^2$

b. Set up Schrodinger's time-independent wave equation. **(08 Marks)**

c. Using uncertainty principle, prove that free electron does not exist inside the nucleus. **(04 Marks)**

d. A spectral line of wavelength 4000 A°U has width of $8 \times 10^{-5}$ AU. Evaluate the minimum time spent by electrons in upper energy state between excitation and de-excitation processes. **(04 Marks)**

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

i) The free electrons in classical free electron theory are treated as:
A) rigidly fixed lattice points B) liquid molecules C) gas molecules D) none of these

ii) The temperature dependence of classical expression for electrical resistivity of a metal is,
A) $\rho\alpha T^{1/2}$ B) $\rho\alpha T^2$ C) $\rho\alpha 1/T^2$ D) $\rho\alpha 1/T$

iii) The value of Fermi function in Fermi-level is at $T \neq 0$ K,
A) zero B) 0.5 C) 0.75 D) 1

iv) If $E_F$ is the Fermi energy at absolute zero, then mean energy $\bar{E}$ of electron at absolute zero is,
A) $\bar{E} = 1.5E_F$ B) $\bar{E} = 2/3\ E_F$ C) $\bar{E} = 2/5\ E_F$ D) $\bar{E} = 3/5\ E_F$

b. Explain failure of classical free electron theory. **(06 Marks)**

c. What are the merits of quantum free electron theory? **(06 Marks)**

d. Calculate the Fermi velocity and mean free path for conduction electrons in silver, given that its Fermi energy is 5.5 eV and relaxation time for electrons is $3.83 \times 10^{-14}$ s. **(04 Marks)**

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

i) The electric dipole moment per unit volume is,
A) magnetization B) dipole moment C) electric polarization D) electric susceptibility

ii) Clausius - Mosotti equation does not holds for,
A) crystalline solids B) liquids C) gases D) vacuum

iii) The relation between B, M and H is,
A) $H = \mu_0(M + B)$ B) $B = \mu_0(H + M)$ C) $M = \mu_0(H + B)$ D) None of these

iv) Above curie temperature ferromagnetic substance becomes:
A) anti-ferromagnetic B) strongly ferromagnetic C) paramagnetic D) diamagnetic

b. Discuss polarization mechanism in dielectrics and their frequency dependence. (08 Marks)

c. Differentiate hard and soft magnetic materials with suitable application. (04 Marks)

d. An electric field of $10^5$ V/m is applied on a sample of neon at NTP. Calculate the dipole moment induced in each atom. The dielectric constant of neon is 1.00014. Find the atomic polariziability of neon gas. At NTP 1 kg atom of Ne – gas occupies volume of 22.4 $m^3$. (04 Marks)

## PART – B

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

i) In He-Ne laser the laser emission takes place from,
A) He-atoms only B) Ne-atoms only
C) both He and Ne atoms D) 50% from Helium and 50% from Neon

ii) Which of the following leads coherent light:
A) induced absorption B) Spontaneous emission C) Stimulated emission D) None of these

iii) The pumping method used in semiconductor diode laser is,
A) optical pumping B) electric discharge C) forward bias D) chemical reactions

iv) The life time of metastable state is about,
A) $10^{-3}$ sec B) $10^{-13}$ sec C) $10^{2}$ sec D) $10^{-9}$ sec

b. Obtain an expression for energy density of radiation under equilibrium condition in terms of Einstein coefficient. (08 Marks)

c. What is holography? Explain principle of hologram recording using laser. (04 Marks)

d. A pulsed laser with power 1 mw lasts for ions. If the number of photons emitted per second is $5 \times 10^{7}$. Calculate the wavelength of laser. (04 Marks)

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

i) According to BCS theory, the cooper pair is pair of,
A) Electron-Proton B) Electron-Electron C) Proton-Proton D) Electron-Neutron

ii) High temperature superconductors bear the crystal structure of,
A) cubic B) orthorhombic C) diamond D) perovskite

iii) The acceptance angle of optical fiber whose RI of core and cladding of 1.55 and 1.50 respectively is,
A) 32° B) 45° C) 23° D) 15°

iv) According to Meissner effect, material in super conducting state is,
A) paramagnetic B) diamagnetic C) ferromagnetic D) anti-ferromagnetic

b. What is refractive index profile? Describe three types of optical fiber with one application for each type. (08 Marks)

c. Explain working of SQUID with application. (04 Marks)

d. An optical fiber of 600 mts long has input power of 120 mw which emerges out with power of 90 mw. Find attenuation in the fiber. (04 Marks)

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

i) The lattice parameters $a = b \neq c$ and $\alpha = \beta = \gamma = 90°$ represent,
A) cubic B) tetragonal C) rhombohedral D) orthorhombic

ii) The co-ordination number of rock salt is,
A) 6 B) 8 C) 12 D) 14

iii) Which of the following has least packing fraction,
A) sc B) bcc C) fcc D) diamond

iv) In a simple cubic lattice $d_{111} : d_{110} : d_{100} =$
A) $\sqrt{6} : \sqrt{3} : \sqrt{2}$ B) $\sqrt{2} : \sqrt{6} : \sqrt{3}$ C) $\sqrt{2} : \sqrt{3} : \sqrt{6}$ D) $\sqrt{3} : \sqrt{6} : \sqrt{2}$

b. Derive expression for interplanar spacing of crystal in terms of Miller Indices. (07 Marks)

c. What is atomic packing factor? Calculate packing factor for sc and bcc structure. (05 Marks)

d. What is Miller Index of plane making intercepts ratio 3a : 4b on x- and y- axis and parallel to z-axis. a, b are primitive vectors? (04 Marks)

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

i) A bulk material (three dimensions) reduced in one direction is called quantum:
A) particle B) well C) dot D) wire

ii) Which belongs to fullerene family?
A) $C_{60}$ B) $C_{70}$ C) $C_{120}$ D) All

iii) Velocity of ultrasound through liquid is proportional to,
A) density B) volume C) bulk modulus D) rigidity modulus

iv) Ultrasonic waves cannot be transmitted through,
A) solid B) liquid C) gas D) vacuum

b. What is NDT? Describe the NDT method of detection of flows in solid using ultrasound. (08 Marks)

c. What are nano materials? Write the structure and applications of carbon nano tubes. (08 Marks)