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10PHY12/22

First/Second Semester B.E. Degree Examination, Dec.2018/Jan.2019
Engineering Physics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, choosing at least two from each part.***

2. ***Physical constants :*** $h = 6.625\times10^{-34}$ ***Js,*** $C = 3\times10^{8}$ ***m/s,*** $m_e = 9.1\times10^{-31}$ ***kg,***

$K = 1.38\times10^{-23}$ ***J/K,*** $\varepsilon_0 = 8.854\times10^{-12}$ Fm^{-1}

PART – A

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

i) When heated, a perfect blackbody is expected to emit radiations.
A) Of only short wavelength B) Of only longer wavelength
C) In only the visible range D) Of all wavelengths

ii) Compton effect establishes,
A) Wave nature of electron B) Particle nature of electron
C) Wave nature of X-ray radiation D) Particle nature of X-ray radiation.

iii) In a Davisson and Germer's experiment for an accelerating potential of 54 V, the constructive interference was observed for electrons scattered at an angle of,
A) $\phi = 30^\circ$ B) $\phi = 50^\circ$ C) $\phi = 65^\circ$ D) $\phi = 90^\circ$

iv) The de Broglie wavelength of an electron accelerated through a potential of 60 V is,
A) 1.850 A° B) 1.584 A° C) 15.84 A° D) 18.50 A°

b. State and explain Planck's law of radiation and hence deduce Rayleigh-Jeans law. **(06 Marks)**

c. Define phase velocity and group velocity. Derive an expression for group velocity on the basis of superposition of two travelling waves. **(07 Marks)**

d. Estimate the potential difference through which a proton is needed to be accelerated so that it's de Broglie wavelength becomes equal to 1 A° given that it's mass is 1.673×10^{-27} kg. **(03 Marks)**

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

i) The wavelength of a proton of mass 1.67×10^{-27} kg moving with a velocity of 2×10^{3} m/s is,
A) 1.98 μm B) 1.98 nm C) 19.8 nm D) 0.198 nm

ii) According to Max Born's interpretation, $|\psi|^2$ represents
A) Energy density B) Particle density
C) Probability density D) Charge density

iii) If E_1 is the energy of the lowest state of an one dimensional potential box of length 'a' and E_2 is the energy of the lowest state when the length of the box is halved, then
A) $E_2 = E_1$ B) $E_2 = 2E_1$ C) $E_2 = \frac{E_1}{2}$ D) $E_2 = 4E_1$

iv) The energy of the lowest state in one dimensional infinite potential well of width 'a' is,
A) zero B) $\frac{2h^2}{8ma^2}$ C) $\frac{h^2}{8ma^2}$ D) $\frac{h}{8ma^2}$

b. Show that electron does not exist inside the nucleus. **(06 Marks)**

c. Set up time independent one-dimensional Schrodinger's equation. **(07 Marks)**

d. An excited atom gives up it's excess energy by emitting a photon of characteristic frequency. The average period that elapses between the excitation of an atom and the time it radiates is 0.1 nsec. Find the inherent uncertainty in the frequency of the photon. **(03 Marks)**

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

i) If the Fermi energy of Silver is 5.5 eV, the Fermi velocity of conduction electrons is,

A) 0.98×10^{6} m/s B) 1.39×10^{6} m/s C) 2.46×10^{5} m/s D) None of these

ii) The electron mobility in metal is given by,

A) $\frac{\tau}{E}$ B) $\frac{e\tau}{m}$ C) σE D) $E\frac{e\tau}{m}$

iii) The collision time and root mean square velocity of an electron at room temperature are 3×10^{-14} s and 10^{+5} m/s respectively. The classical value of mean free path of the electron is,

A) 3×10^{-19} nm B) 3 A° C) 3 nm D) 17.3 nm

iv) The Fermi energy of a metal at absolute zero temperature is proportional to,

A) $n^{\frac{1}{3}}$ B) $n^{\frac{3}{2}}$ C) $n^{\frac{2}{3}}$ D) n^{2}

b. Based on classical free electron theory derive an expression for electrical conductivity of metals. **(06 Marks)**

c. Describe how quantum free electron theory has been successful in overcoming the failures of classical free electron theory. **(06 Marks)**

d. Calculate the probability of an electron occupying energy level of 0.2 eV above the Fermi level at 300 K and 1000 K in a metal. **(04 Marks)**

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

i) Ferro electricity is observed in,

A) Magnetic hysteresis in Iron
B) Electrical hysteresis in Iron
C) Magnetic hysteresis in dielectric materials
D) Electric hysteresis in dielectric materials.

ii) What changes in the capacitance of a capacitor occurs if the dielectric material is removed?

A) Increases B) Decreases C) No change D) None of these

iii) The polarization that occurs in the frequency range 10^{13} to 10^{16} Hz is,

A) Electronic B) Orientational C) Ionic D) Space charge

iv) Which of the following is a diamagnetic material?

A) Copper B) Platinum C) Nickel D) Iron

b. Describe any three types of polarization mechanisms. **(06 Marks)**

c. Derive an expression for internal field in case of one dimensional array of atoms in dielectric solids. **(06 Marks)**

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

PART – B

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

i) Important characteristics of laser beam is,

A) Interference B) Diffraction C) Dispersion D) Coherence

ii) The lifetime of an atom at the ordinary excited state is of the order of,

A) A few millisecond B) few nanosecond
C) few microsecond D) Unlimited

iii) A semiconductor laser has a peak emission radiation of wavelength of 1.24 μm. What is it's band gap value in eV?

A) 2 eV B) 1 eV C) 1.24 eV D) 2.48 eV

iv) 3D image of an object recorded on a hologram is the process of recording of,

A) Intensity variation B) Phase variation
C) Both phase and intensity variation D) Transmission and reflection variation.

b. Obtain an expression for energy density of radiation under equilibrium condition in terms of Einstein coefficients. **(06 Marks)**

c. Describe the construction of He-Ne Laser and explain it's working with the help of energy level diagram. **(07 Marks)**

d. The ratio of population of two enegy levels is 1.059×10^{-30}. Find the wavelength of light emitted by spontaneous emissions at 300 K. **(03 Marks)**

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

i) Fractional Index change for an optical fiber with core and cladding of refractive indices 1.563 and 1.498 respectively is,
A) 0.00415 B) 0.04159 C) 0.04300 D) 0.00400

ii) Delay distortion occurs due to,
A) Irregularities in fiber structure
B) Variation in refractive index of the core at different points
C) Spreading of pulses
D) Macroscopic bends.

iii) Superconductivity can be destroyed,
A) Only by increasing the temperature
B) Only by increasing the magnetic field
C) By increasing both magnetic field and temperature
D) By decreasing both magnetic field and temperature

iv) The quantum of magnetic flux is given by,
A) $\frac{2h}{e}$ B) $\frac{h}{2e}$ C) $\frac{h}{2\pi e}$ D) $\frac{2\pi h}{e}$

b. Obtain an expression for the numerical aperture. Also explain the principle on which optical fiber works. **(07 Marks)**

c. Explain any two applications of superconductivity. **(06 Marks)**

d. The attenuation of light in an optical fiber is 3.6 dB/km. What fraction of it's initial intensity remains after 3 km? **(03 Marks)**

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

i) The Miller indices of the plane parallel to X and Y axes are,
A) (1 0 0) B) (0 1 0) C) (0 0 1) D) (1 1 1)

ii) The number of molecules present in unit cell of sodium chloride is,
A) 5 B) 2 C) 4 D) None of these

iii) The packing factor of diamond crystal structure is,
A) 34% B) 52% C) 68% D) 74%

iv) In Bragg's spectrometer, for every rotation θ, of the turn table, the detector turns by an angle
A) θ B) 2θ C) 3θ D) 4θ

b. With neat diagram, explain the crystal structure of sodium chloride. **(06 Marks)**

c. Explain how Bragg's spectrometer is used for determination of interplanar spacing in a crystal. **(07 Marks)**

d. Draw the crystal planes in cubic unit cell for following miller indices:
(i) (1 0 2) (ii) $(\bar{2}\ \bar{1}\ 1)$ (iii) (2 0 0) **(03 Marks)**

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

i) Carbon nanotubes are made up of,
A) Graphene B) Mica sheet layers C) Honey comb D) Plastic

ii) Bulk material reduced to 2-dimensions is known as,
A) Quantum dot B) Quantum wire C) Film D) Quantum particle

iii) A method of testing a product without causing any damage is called,
A) Minute testing B) Destructive testing
C) Non-destructive testing D) Random testing

iv) The signal due to reflected wave is called,
A) Transmitted wave B) Longitudinal wave
C) Echo D) Peaco

b. Write a note on fullerene. What are the potential applications of fullerenes? (08 Marks)

c. Explain with principle, how the flaw in a solid can be detected by non-destructive method using ultrasonics. (08 Marks)

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