



First Semester B.E. Degree Examination, June/July 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 : $h = 6.625 \times 10^{-34}$ J-Sec, $\epsilon_0 = 8.854 \times 10^{-12}$ Farads/m, $m_e = 9.1 \times 10^{-31}$ kgs, $N_A = 6.025 \times 10^{26}$ /k - mole, $c = 3 \times 10^8$ mn/Sec, $k = 1.38 \times 10^{-23}$ J/K.

PART - A

- 1 a. Choose your answers for the following :
- Let n_r and n_b be the number of photons emitted by a red bulb and a blue bulb respectively having equal power. Then
A) $n_r = n_b$ B) $n_r < n_b$ C) $n_r > n_b$ D) The information is insufficient to get a relation between n_r and n_b .
 - An electron, neutron and a proton have the same de - Broglie wavelength which particle has greater velocity.
A) Proton B) Neutron C) Electron D) All particles have same velocity.
 - If a charged particle of mass m is accelerated through a potential difference of V volts, the de - Broglie wavelength is proportional to
A) V B) $V^{-1/2}$ C) $V^{1/2}$ D) V^2
 - The wavelength of matter waves is independent of
A) Mass B) Charge C) Momentum D) velocity. (04 Marks)
- b. Give an account of the attempts made through various laws to explain the black body spectrum. (06 Marks)
- c. What is group velocity? Show that group velocity of de - Broglie wave length is equal to velocity of the particle with which the waves are associated. (06 Marks)
- d. Calculate the kinetic energy of an electron whose de - Broglie wavelength is equal to that of a 10 keV photon. (04 Marks)
- 2 a. Choose your answers for the following :
- If the uncertainty in the location of a particles is equal to its de - Broglie wavelength, the uncertainty in its velocity is of the order of
A) its velocity B) half its velocity C) twice its velocity D) Four times its velocity
 - If an electron moves in a 1 - D box of length 2 nm, the normalization constant is
A) $(1 \text{ nm})^{-1/2}$ B) $(2 \text{ nm})^{-1}$ C) $\sqrt{2}(\text{nm})^{-1}$ D) 0
 - A free particle can carry any amount of energy and hence its energy is
A) Discrete B) Continuous C) Degenerate D) Neither continuous nor discrete.
 - The lowest possible energy for a particle in a potential well of infinite height is 2 eV. Its energy in the first excited state is
A) 4 eV B) 8 eV C) 16 eV D) 21 eV. (04 Marks)
- b. Set up time independent Schrödinger's wave equation for free particle in one - dimensional (06 Marks)
- c. What is the physical significance of the wave function? Also discuss the nature of eigen values and eigen functions. (06 Marks)
- d. The velocity of an electron was measured to be 5×10^5 mts/sec with an uncertainty of 1%. What is the uncertainty involved in the measurement of its position? (04 Marks)

3 a. Choose your answers for the following :

i) The temperature dependence of classical expression for electrical resistivity of metal is

A) $\rho \propto T^2$ B) $\rho \propto \frac{1}{T^2}$ C) $\rho \propto T^{1/2}$ D) $\rho \propto \frac{1}{T}$

ii) If the Fermi energy of a metal is 3 eV the Fermi temp of the metal is

A) 3.4×10^4 k B) 1.6×10^2 k C) 4.8×10^3 k D) 10^{-12} k

iii) The quantum mechanical expression for electrical conductivity is

A) $\sigma = \frac{ne^2\lambda_F}{m^*v_F}$ B) $\sigma = \frac{m^*v_F}{\lambda_F ne^2}$ C) $\sigma = \frac{ne^2\lambda}{m^*}$ D) $\sigma = \frac{m^*}{ne^2\lambda_F}$

iv) If mobility of electrons in a metal increases, the resistivity

A) Decreases B) Increases C) Remains constant D) None of the above.

(04 Marks)

b. Derive an expression for density of states as per quantum free electron theory. (08 Marks)

c. Discuss effects of temperature and impurity on electrical resistivity of metals. (04 Marks)

d. Calculate the Fermi velocity and mean free path for conduction electrons in aluminium given that its Fermi energy is 91.63 eV and relaxation time for electron is 7.3×10^{-15} sec.

(04 Marks)

4 a. Choose your answers for the following :

i) Clausius – Mossotti equation with usual meaning of notations can be written as

A) $\frac{\epsilon_r + 2}{\epsilon_r - 1} = N\alpha_e$ B) $\frac{\epsilon_r + 1}{\epsilon_r - 2} = \frac{N\alpha_e}{3\epsilon_0}$
 C) $\frac{\epsilon_r - 1}{\epsilon_r + 2} = \frac{N\alpha_e}{3\epsilon_0}$ D) $\frac{\epsilon_r + 2}{\epsilon_r - 1} = \frac{N\epsilon_0}{3\alpha_e}$

ii) Insertion of a dielectric material between the plates of a capacitor

A) Increases the capacitance B) Decreases the capacitance
 C) Results no change in capacitance D) None of above.

iii) For a given dielectric the electronic polarizability α_e ,

A) increases with temperature
 B) decreases with temperature
 C) is not affected by temperature change
 D) May increase decrease with temperature.

iv) The area of hysteresis loop of a ferromagnetic material gives

A) coercive force B) Remanent flux density
 C) intensity of magnetization D) hysteresis loss. (04 Marks)

b. Derive Clausius – Mossotti equation for a dielectric material. (06 Marks)

c. Explain magnetic hysteresis on the basis of domain theory. (05 Marks)

d. Sulphur is elemental solid dielectric whose dielectric constant is 3.4. Calculate electronic polarizability if its density is 2.07×10^3 kg/m³ and atomic weight is 32.07. (05 Marks)

PART – B

- 5 a. Choose your answers for the following :
- In spontaneous emission the emitted photon can move
 - in the direction of field
 - in a straight direction
 - in any random direction
 - opposite to the direction of field.
 - A laser requires mirrors because
 - they provide optical feed back
 - they invert the population inversion
 - they determine the wavelength at which lasing occurs
 - None of these
 - Ratio of probabilities of spontaneous emission and stimulated emission is
 - Proportional to frequency γ
 - Independent of frequency γ
 - Proportional to γ^2
 - Proportional to γ^3
 - The wavelength of He – Ne laser is
 - 6943 \AA
 - 6328 \AA
 - 6534 \AA
 - 6845 \AA .
- b. Explain the following terms
- Stimulated emission
 - population inversion
 - Spontaneous emission.
- c. Write a note on measurements of pollutants in the atmosphere using laser.
- d. A pulsed laser has an average power output of 1.5 mW per pulse and pulse duration is 20 nS. The number of photons emitted per pulse is estimated to be 1.0472×10^8 . Find the wavelength of the emitted laser.
- 6 a. Choose your answers for the following :
- In an optical fibre if n_1 is R. I of the core and n_2 that of cladding, then
 - $1 - \frac{n_2}{n_1} > 1$
 - $1 - \frac{n_2}{n_1} = 0$
 - $1 - \frac{n_2}{n_1} < 1$
 - $\frac{n_2 - n_1}{n_1} = \infty$
 - Which of the following is correct?
 - cladding is for providing greater mechanical strength
 - core has higher R.I than cladding
 - cladding has higher R.I. than the core
 - None of these.
 - The relation between T_c and H_c for a super conductor is
 - $H_c = H_0 (1 + T^2)$
 - $H_c = T_c^2$
 - $H_c = H_0 \left[1 - \left(\frac{T}{T_c} \right)^2 \right]$
 - $H_c = H_0 \left[1 + \left(\frac{T}{T_c} \right)^2 \right]$
 - Type – II superconductor has
 - only one critical magnetic field
 - Two critical magnetic fields
 - Three critical magnetic fields
 - All above are false.
- b. What are the different losses in optical fibres? Write a brief note on each.
- c. The numerical aperture of an optical fibre is 0.2 when surrounded by air. Determine the R. I. of core, given R. I. of cladding 1.59. Also find acceptance angle when the fibre is surrounded by water.
- d. Discuss the Maglev vehicles.

7 a. Choose your answers for the following :

i) The number of lattice points in a primitive cell are

- A) 1 B) 1/2 C) 2 D) 3/2

ii) The Miller indices of the plane parallel the x and y axis are

- A) (100) B) (010) C) (111) D) (001)

iii) The packing factor of the B.C.C structure is

- A) 52% B) 68% C) 92% D) None of the above

iv) For a cubic system the inter planar spacing for (111) plane is

- A) $\frac{a}{\sqrt{2}}$ B) $\frac{a}{\sqrt{3}}$ C) $\frac{a}{2}$ D) $\frac{a}{2\sqrt{2}}$ (04 Marks)

b. Define : i) Co-ordination number

ii) Packing factor. Calculate packing factor for B.C.C structure. (06 Marks)

c. Derive Bragg's law for x – ray diffraction. (04 Marks)

d. Draw the following plane in a simple cubic crystal

i) (132)

ii) (T 10)

iii) (010). (06 Marks)

8 a. Choose your answers for the following :

i) Ultrasonics are

- A) Sound waves of frequencies > 20 Hz
 B) Sound waves of frequency > 20 KHz
 C) Transverse waves
 D) None of the above

ii) Carbon nanotubes are made up of

- A) Graphite sheet B) Plastic C) Glass D) All above

iii) Non destructive testing of materials can be carried out by

- A) Ultrasonic method B) X- ray method C) Magnetic methods D) All the above

iv) The bulk material when reduced in three dimensions is known as

- A) Quantum wire B) Quantum dot C) Film D) None of above. (04 Marks)

b. Give an account of carbon nanotubes. (06 Marks)

c. Describe in detail how a flow in solid material is detected by non destructive method using ultrasonics. (10 Marks)

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 $k = 1.38 \times 10^{-23} \text{ JK}^{-1}$, $\epsilon_0 = 8.854 \times 10^{-12} \text{ Fm}^{-1}$.

PART - A

- 1 a. Choose your answers for the following :
- In Compton Effect, the wavelength of the x-rays scattered at an angle $\theta > 0$.
 A) increases B) doesn't change C) decreases D) none of these
 - K_e , K_p and K_α an respective kinetic energy of an \bar{e} , a proton and α - particle of same de-Broglie wavelength, then
 A) $K_e > K_p > K_\alpha$ B) $K_e > K_p < K_\alpha$ C) $K_e < K_p < K_\alpha$ D) $K_e = K_p = K_\alpha$
 - The heavier of the particles has smallest de-Broglie wave length when both of them.
 A) move with same speed B) move with same momentum
 C) move with same kinetic energy D) none of these
 - Matter waves are not electromagnetic waves because
 A) they move with variable velocity B) depend on charge
 C) move with constant velocity D) none of these (04 Marks)
- b. What are the basic postulates of quantum theory of radiations? Explain how Planck's overcome the drawbacks of Weins law and Rayleigh Jean's law. (06 Marks)
- c. Define group and phase velocity. Derive the expression for de-Broglie wavelength using group velocity concept. (06 Marks)
- d. Compute the de Broglie wavelength for a neutron moving with one tenth part of the velocity of light. (04 Marks)
- 2 a. Choose your answers for the following :
- An electron is moving in a box of length a ; if ψ_1 is the wave function at $x = \frac{a}{4}$ with $n = 1$ and ψ_2 at $x = a$ for $n = 2$, then $\frac{\psi_2}{\psi_1}$ is
 A) $\frac{\sqrt{2}}{a}$ B) $\frac{\sqrt{a}}{2}$ C) 0 D) ∞
 - For a particle in an infinite potential well in its 1st excited state, the probability of finding the particle at the center of box is
 A) 0 B) 0.25 C) 0.5 D) 0.1
 - To become a nuclear constituent, the K.R of \bar{e} must be of the order of
 A) 20 MeV B) 2 MeV C) 20eV D) zero
 - An electron has a speed of 100 m/s accurate to 0.05%. The uncertainty in its position is
 A) 0.01m B) 0.0115m C) 0.024m D) 0.04m (04 Marks)

- b. What is a wave function? Explain the properties of a wave function. (04 Marks)
- c. Derive the expression for energy eigen value for an electron in potential well of infinite depth. (06 Marks)
- d. A quantum particle confined to one-dimensional box of width 'a' is in its first excited state. What is the probability of finding the particle over an interval of $\left(\frac{a}{2}\right)$ marked symmetrically at the centre of box. (06 Marks)
- 3 a. Choose your answers for the following :
- i) If the mobility of \bar{e} in a metal increases the resistivity
 A) decreases B) increases C) remains constant D) none of these
- ii) The temperature dependence of electrical resistivity of metal is
 A) $\rho \propto \frac{1}{T}$ B) $\rho \propto \frac{1}{\sqrt{T}}$ C) $\rho \propto \sqrt{T}$ D) $\rho \propto T$
- iii) Zero percentage probability is the probability for \bar{e} to occupy the energy level above the Fermi energy level at $T = 0\text{K}$ is
 A) $E + E_F$ B) $E = E_F$ C) $E > E_F$ D) $E < E_F$
- iv) If the Fermi energy of a metal is 1.4eV, the Fermi temperature of the metal is approximately
 A) $1.6 \times 10^3 \text{K}$ B) $1.6 \times 10^4 \text{K}$ C) $1.6 \times 10^5 \text{K}$ D) $1.6 \times 10^6 \text{K}$ (04 Marks)
- b. Discuss the various drawbacks of classical free electron theory of metals. What are the assumptions made in Quantum theory to overcome the same? (06 Marks)
- c. Explain density of states? Derive the expression for electrical conductivity in terms of mean collision time. (06 Marks)
- d. The Fermi level potassium is 2.1eV. What are the energies for which the probabilities of occupancy at 300 K are 0.99 and 0.5? (04 Marks)
- 4 a. Choose your answers for the following :
- i) For ferromagnetic substances, the Curie-Weise law is given by
 A) $\psi = \frac{C}{T}$ B) $\psi = \frac{C}{T - \theta}$ C) $\psi = \frac{T - \theta}{C}$ D) $\frac{C}{T - \theta}$
- ii) Clausius-Mossotti equation does not hold for
 A) gasses B) liquids C) crystalline solids D) none of these
- iii) The Ferro electric material losses spontaneous polarization at
 A) room temperature B) 0 K C) $T_c\text{K}$ D) 100 K
- iv) In hysteresis, polarization
 A) moves with the electric field B) lags behind electric field
 C) ahead to the electric field D) none of these. (04 Marks)
- b. Explain the term internal field. Derive an expression for internal field in the case of one dimensional array of atoms in di-electric solids. (07 Marks)
- c. Derive Clausius-Mossotti equation. (04 Marks)
- d. Sulphur is elemental solid di-electric whose di-electric constant is 3.4. Calculate the electronic polarizability if its density is $2.07 \times 10^3 \text{kg/m}^3$ and atomic weight is 32.07. (05 Marks)

PART – B

- 5 a. Choose your answers for the following :
- Wavelength of a laser beam can be used as a standard of
A) time B) temperature C) angle D) length
 - Image is stored on a hologram in the form of
A) interference pattern B) diffraction pattern
C) photograph D) none of these
 - Which event is likely to take place, when a photon of energy equal to the difference in energy between two levels is incident in a system
A) absorption B) emission
C) absorption and emission D) none of these
 - Quartz plates are fixed at the ends of the discharge tube in a He-Ne laser so that
A) there won't be leakage of gas
B) the tube can withstand high electric voltage
C) the losses of light can pass out without any loss
D) the emergent light is polarized (04 Marks)
- b. Explain the requisites and conditions of a laser system. (05 Marks)
- c. Describe the principle and working of LIDAR used to measure pollutant in atmosphere. (06 Marks)
- d. Find the number of modes of standing waves and their frequency separation in the resonant cavity of 1m length of He-Ne operating at a wavelength of 632.8nm. (05 Marks)
- 6 a. Choose your answers for the following :
- The conductivity of a superconductor is
A) infinite B) zero C) finite D) none of these
 - The relation between superconducting transition temperature (T_C) and atomic weight (μ) of isotope is
A) $T_C \propto \mu$ B) $T_C \propto \frac{1}{\mu}$ C) $T_C \propto \sqrt{\mu}$ D) $T_C \propto \frac{1}{\sqrt{\mu}}$
 - If optic fibre is kept in a medium of R.I. $\mu (>1)$ instead of air, the acceptance angle
A) increases B) decreases C) remains constant D) none of these
 - In graded index fibre, the R.I. of cladding varies
A) exponentially B) linearly C) parabolically D) none of these (04 Marks)
- b. Discuss types of optical fibres and modes of propagation using suitable diagram. (06 Marks)
- c. Distinguish between type- I and type – II superconductors. (05 Marks)
- d. The angle of acceptance of an optical fibre is 30° when kept in air. Find the angle of acceptance when it is in a medium of R.I. 1.33. (05 Marks)
- 7 a. Choose your answers for the following :
- Four types of Bravais lattices are obtained in
A) rhombohedral system B) orthorhombic system
C) triclinic system D) monoclinic system
 - In BCC structure, the packing density of crystal is equal to
A) $\frac{\sqrt{3}\pi}{8}$ B) $\frac{\sqrt{3}\pi}{8}$ C) $\frac{3\pi}{8}$ D) $\frac{3\sqrt{3}\pi}{8}$

- 7 a. iii) Which of the following has greatest packing fraction
 A) simple cubic B) body centred cubic
 C) face centred cubic D) all have equal packing fraction
- iv) The space lattice of diamond is
 A) simple cubic
 B) body centred cubic
 C) face centred cubic with two atoms/unit cell
 D) face centred cubic with four atoms/unit cell (04 Marks)
- b. With a neat figure, explain the structure of diamond and show that atomic packing factor of diamond is 0.34. (10 Marks)
- c. Calculate the glancing angle of the (110) plane of a simple cubic crystal ($a = 2.814 \text{ \AA}$) corresponding to second order diffraction maximum for the x-rays of wavelength 0.710 \AA . (06 Marks)
- 8 a. Choose your answers for the following :
- i) The state of matter around the name – size is known as
 A) solid state B) liquid state
 C) plasma state D) mesoscopic state
- ii) The ultrasonic waves are detected by
 A) electromagnetic induction B) tuning fork
 C) piezo electric effect D) inverse piezo electric effect
- iii) A constant testing of product without causing any damage is called
 A) minute testing B) destructive testing
 C) non-destructive testing D) random testing
- iv) The frequency of ultrasonic waves is
 A) < 20 kHz B) between 20 Hz and 20 kHz
 C) > 20 kHz D) none of these (04 Marks)
- b. Describe a method for measurement of velocity of ultrasonic waves in a liquid and mention how the bulk modulus of the liquid could be evaluated. (08 Marks)
- c. Write a note on carbon nano tube. Discuss the various quantum structures. (08 Marks)

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