2103000205021002
EXAMINATION FEBURARY-MARCH 2024
BACHELOR OF SCIENCE (FIFTH SEMESTER)
PHYSICS-VII
(PH-507-ELECTRODYNAMICS AND OPTICS) - LEVEL 2

[**Time: As Per Schedule]** **[Max. Marks: 50]**

Instructions:
1. Fill up strictly the following details on your answer book
   a. Name of the Examination: **BACHELOR OF SCIENCE (FIFTH SEMESTER)**
   b. Name of the Subject: **PHYSICS-VII (PH-507-ELECTRODYNAMICS AND OPTICS) - LEVEL 2**
   c. Subject Code No: **2103000205021002**
2. Sketch neat and labelled diagram wherever necessary.
3. Figures to the right indicate full marks of the question.
4. All questions are compulsory.
5. Symbols used in the question paper have their usual meanings.
6. Students are permitted to use non-programmable scientific calculator.

Seat No:

Student's Signature

Q.1 Answer the following in brief. **10**

1. State Gauss' law in the presence of dielectric.
2. Define: Intensity of polarization for a dielectric.
3. In electrostatics, curl $\vec{E}$ = _____.
4. The net magnetic moment of a paramagnetic material is _____. (0, positive, negative)
5. State the unit and dimensional formula of orbital angular momentum.
6. Which force provides the necessary centripetal force to the electron to move on a circular path around the nucleus in the absence of any external field?
7. What is coherence?
8. Two transverse waves are propagating in the same direction. At a point, crest of one wave falls on the trough of the other. Which type of interference would be observed there?
9. Define: critical angle.
10. Give an expression for spatial frequency.

Q.2 (A) Attempt any one of the following. **7**

(1) Explain the origin of volume charge density and surface charge density of a polarized dielectric.

(2) Starting from $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$, show that curl of displacement field is not always zero. What do you conclude as a result?

(B) Solve any one of the following. **3**

(1) Find the electric field produced by a uniformly polarized sphere of radius R.

(2) Determine the electric permittivity and electric susceptibility of Bakelite if its dielectric constant is 4.9, given that $\epsilon_0 = 8.85 \times 10^{-12} MKS$.

Q.3 (A) Attempt any one of the following. **7**

(1) Describe the origin of bound currents.

(2) For a non-uniformly magnetized material, show that $\vec{j}_b = \vec{\nabla} \times \vec{M}$.

(B) Solve any one of the following. **3**

(1) A 40 *cm* long conductor is placed in a magnetic field of $\vec{B}$ = (12î - 5ĵ) *T* such that its length remains parallel to z-axis. What will be magnitude of the force acting on it when a current of 200 *mA* is passed through it? If the current is made 1 *A*, then what will be magnitude of the force acting on it now?

(2) Magnetization in a non-uniformly magnetized material varies as $\vec{M} = 2(x + y)\hat{k} - 3(y - z)\hat{j}\ \frac{A}{m}$, where *x*, *y* and *z* are in *mm*. Calculate the magnitude of bound current density in it.

Q.4 (A) Attempt any one of the following. **7**

(1) Explain the construction and working of Fabry-Perot etalon.

(2) Discuss resolving power of the Fabry-Perot interferometer corresponding to a normally incident beam.

(B) Solve any one of the following. **3**

(1) Consider plane wave to be incident on a plate of thickness 0.75 μm and refractive index 1.55 at an angle of 15°. The wave experiences multiple reflections in the plate. Find the value of phase difference between two successive reflected waves when the monochromatic light of wavelength 6000 Å is incident on it.

(2) Consider a Fabry-Perot interferometer illuminated by collimated beam of white light normally. If the separation between the two plates in it is 1.8 μm and the refractive index of the medium between them is 1.65, (i) how many visible maxima, (ii) of what orders and (iii) of what wavelengths will be observed?

Q.5 (A) Attempt any one of the following. **7**

(1) Explain the theory of recording of a hologram by assuming appropriate equations for the object wave and a reference wave and derive an expression for average intensity.

(2) Explain how double exposure holographic interferometry technique can be used for determining the Young's modulus of a cantilever.

(B) Solve any one of the following. **3**

(1) A plane monochromatic wave of wavelength 500 *nm* is propagating in the XZ plane. Calculate the spatial frequency when it makes an angle of (i) 30° and (ii) 60° with Z axis.

(2) The dimensions of the cross-section of a beam are 2.5 *cm* × 5 *mm*. It is supported on two knife edges kept at a separation of 70 *cm*, and is loaded by 40 g at its center. Find the depression of its center. The Young's modulus of the beam is $Y = 0.98 \times 10^{11}$ *CGS*. $(g = 9.8 \frac{m}{s^2})$

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