RAN-2103000205021002

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B.Sc. (Sem. V) Examination October - 2023

Physics : Paper 507

Electrodynamics and Optics

[Total Marks: 50

સૂચના : / Instructions

(૧) **નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.**
Fill up strictly the details of ☛ signs on your answer book

Name of the Examination:

☛ **B.Sc. (Sem. V)**

Name of the Subject :

☛ **Physics : Paper 507**
Electrodynamics and Optics

Subject Code No.: **2103000205021002**

Seat No.:

Student's Signature

(2) Figures on the right indicate the total marks carried by the question.
(3) Symbols used in the question paper have their usual meanings.
(4) Students are permitted to use non-programmable scientific calculator.

Q. 1 Answer the following in brief. (10)

(1) What is a dielectric?
(2) What do you mean by polarization of an atom?
(3) In a polar dielectric at room temperature, how are its intrinsic dipoles oriented?
(4) Is magnetic moment a scalar or a vector? If it is a vector, give its direction.
(5) Force on a current element $Id\vec{l}$ when placed in a magnetic field $\vec{B}$ is given by_____.
(6) State the unit and dimensional formula of magnetic moment.
(7) State condition for constructive interference in terms of phase difference.
(8) State super position principle for waves.
(9) What is the value of transmittivity of the Fabry-Perot etalon at FWHM?
(10) Define: coherent sources.

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

(1) What are polar and non-polar molecules? Explain polarization of polar and non-polar molecules in detail.

(2) The potential due to a polarized dielectric material is given by

$$V(\vec{r}) = \frac{1}{4\pi \in_0} \oint_S \frac{1}{r}\, \vec{p} \cdot d\vec{a} - \frac{1}{4\pi \in_0} \oint_V \frac{1}{r}\, (\vec{\nabla}' \cdot \vec{P}) \cdot d\tau$$

Interpret the terms appearing in this equation.

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

(1) Four electric charges, +1 *nC*, –2 *nC*, +3 *nC* and –4 *nC* are kept at the vertices of square of a side 4 mm. Calculate electrostatic potential at the center of the square.

(2) Show that the potential energy of an ideal electric dipole of dipole moment $\vec{p}$ in a uniform electric field $\vec{E}$ is given by $U = -\vec{p} \cdot \vec{E}$.

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

(1) Explain the behavior of diamagnetic materials in the presence of uniform and non-uniform magnetic fields.

(2) For a uniformly magnetized material, show that

$$\vec{K}_b = \vec{M} \times \hat{n}$$

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

(1) Consider Bohr's model of hydrogen atom. The electron moves in its third orbit at a speed of $7.26 \times 10^5 \ \frac{m}{s}$. What is the value of current produced as a result? How much is its magnetic moment?
(Bohr radius = 52.9 *pm*, $e = 1.6 \times 10^{-19}$ *C*)

(2) A square loop of side 5 *mm* is placed in a uniform magnetic field of 20 *mT* such that its plane remains parallel to the field. If a current of 0.2 *A* is flowing through it, what will be the value of

(i) its magnetic moment and

(ii) torque acting on it?

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

(1) Assume plane wave to be incident on a glass plate. An expression for the transmittivity of the Fabry-Perotetalon is given by

$$T = \frac{1}{1 + F \sin^2\left(\frac{\delta}{2}\right)}$$

Discuss special cases for the values of δ.

(2) Write a short note on: Flatness of the coated surfaces.

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

(1) Consider plane wave to be incident on a plate of thickness 1.2 μm and refractive index 1.6 at an angle of 10°. It experiences multiple reflections in the plate. Find the value of phase difference between two successive reflected waves when the monochromatic light of wavelength 6200 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 is 0.75 μm and the refractive index of the medium between them is 1.7,

(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 and reconstruction of the image from a hologram.

(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 550 nm is propagating in the XZ plane. Calculate the spatial frequency when it makes an angle of

(i) 30° and (ii) 45° with Z axis.

(2) The dimensions of the cross-section of a beam are 2.5 cm × 6 mm and it is supported on two knife edges kept at a separation of 60 cm. When it is loaded by 30 g at its center, the center depresses by 4 mm.

Find the Young's modulus of the beam, ($g = 9.8 \ \frac{m}{s^2}$)