RAN-2103000205021002

RAN-2103000205021002

B. Sc. (Sem.-V) Examination October - 2025

Physics - Electrodynamics and Optics (PH-507)

Time: 2 Hours] **[Total Marks: 50**

સૂચના : / Instructions

(1) ઉપરોક્ત દર્શાવેલ વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fill up strictly the above details on your answer book

(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.

Seat No.:

Student's Signature

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

(1) What do you mean by a linear dielectric?
(2) State the boundary condition for the parallel component of the electric field.
(3) What happens to an electric dipole when it is placed in a non-uniform electric field?
(4) What is Oersted's observation?
(5) What do you mean by free current in a magnetized material?
(6) $\vec{\nabla} \cdot \vec{B}$ is always zero. Agreed?
(7) State the condition for destructive interference in terms of phase difference.
(8) Which information of the object wave is not recorded in an ordinary photograph?
(9) What is interference?
(10) State an expression for free spectral range.

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

(1) Explain the behavior of an electric dipole in the presence of uniform and non-uniform electric field. **(7)**
(2) Obtain modified form of Gauss' law in the presence of dielectric.

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

(1) Find the electric field produced by a uniformly polarized sphere of radius R inside it.
(2) A 47 μF capacitor is connected to a battery of potential difference 200 V. What will be values of charge and energy stored in it?

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

(1) Obtain an expression for torque acting on a current carrying loop placed in a uniform magnetic field.
(2) What is a linear material? Derive $\vec{B} = \mu_0(1 + \chi_m)\ \vec{H}$ for it.

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

(1) A circular loop of radius 1.5 cm, carrying a current 250 mA is suspended above a short solenoid. If the plane of the loop makes an angle of 30° with the magnetic field, what will be magnitude of the force on the loop if the solenoid produces a magnetic field of 4 mT?
(2) An infinitely long solenoid has n turns per unit length and it carries a current I. It is filled with a linear material of susceptibility χ_m. Find the magnetic field inside the solenoid and surface current in terms of magnetic susceptibility.

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

(1) Assume plane wave to be incident on a glass plate. Obtain the following expression for the resultant amplitude due to the waves obtained as a result of multiple reflections from the two surfaces of the plate

$$A_r = A_0 \left[r_1 + \frac{t_1 r_2 t_2 exp(i\delta)}{1 - r_2^2 exp(i\delta)} \right]$$

(2) Explain the construction and working of Lummer-Gehrcke Plate.

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

(1) Sodium lamp is used as a source in a Fabry-Perot interferometer. If the separation between the two plates of the interferometer is 1 *cm*, obtain the value of its resolving power for (i) $F = 80$ and (ii) $F = 1000$. (For sodium lamp, $\lambda_1 = 5890$ Å, $\lambda_2 = 5896$ Å and $c = 3 \times 10^8$ ms^{-1})

(2) Consider a Fabry-Perot interferometer illuminated by collimated beam of white light normally. If the separation between the two plates is 2 μm and the refractive index of the medium between them is 1.5,
(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) An expression for the resultant intensity in the case of double exposure holographic interferometry technique is given by
$I(x,y) = A^2(x,y) + A^2(x,y)\langle \cos[\phi(x,y) - \phi'(x,y)] \rangle$
Discuss the special cases corresponding to the phase difference in this expression.

(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 520 *nm* is propagating in the XZ plane at an angle of 45° with Z axis. Calculate the spatial frequency.

(2) The total field at the photographic plate during the recording process is given by

$$u(x,y,t) = a(x,y)\cos[\phi(x,y) - \omega t] + A\cos[2\pi\alpha x - \omega t]$$

Show that the average intensity recorded in the photographic plate as a result is given by

$$I(x,y) = \frac{1}{2} a^2(x,y) + \frac{1}{2} A^2 + Aa(x,y)\cos[\phi(x,y) - 2\pi\alpha x]$$