RAN-2103000206021002

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B. Sc. (Sem. - VI) Examination September - 2025

Physics (Paper - PH - 607) Electrodynamics and Optics

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

સૂચના : / Instructions

(1) 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. - VI)**

Name of the Subject :

☛ **Physics (Paper - PH - 607) Electrodynamics and Optics**

Subject Code No.: **2103000206021002**

Seat No.:

Student's Signature

(2) Q. 1 is compulsory.

(3) Symbols used in the question paper have their usual meanings.

(4) Students are permitted to use non-programmable scientific calculator.

(5) Figures on the right indicate the total marks carried by the question.

Q. 1. Answer <u>any ten</u> in brief. **(10)**

1. Define: Inductor.
2. The resistivity of a wire of length $1\,m$ and diameter $2\,\text{mm}$ is $1.8 \times 10^{-8}\ \Omega\,m$. What will it be for a wire of length $2\,m$ and diameter $1\,mm$?
3. What is mutual-induction?
4. What do you mean by pure Faraday field?
5. Which of the Maxwell's equations prove that the magnetic monopole does not exist?
6. State boundary condition for the field $\vec{D}$ across an interface of two media.
7. State any one law of refraction.

8. The value of intrinsic impedance of free space is _____ .
9. What is the dimensional formula of amplitude transmission coefficient?
10. The output is one-tenth of the input from an optical fiber. What will be the value of loss in dB?
11. What is the unit of numerical aperture?
12. When white light is coupled into a long fibre, the output looks reddish. This is because of _____ .

Q. 2. A. Attempt <u>any one</u> of the following. **(07)**

1. Prove that the electric field inside a conductor is zero. Any unbalanced charge resides on its surface only, using vector form of Ohm's law.
2. Consider a conducting loop kept in a uniform magnetic field ($\vec{B}$) such that the plane of the loop remains perpendicular to the field lines. Suppose this loop is pulled out of the magnetic field. Show that the work done per unit charge on the loop is equal to the *emf* induced in it.

B. Solve <u>any one</u> of the following. **(03)**

1. 2.5 A current is passed through a 470 $k\Omega$ resistance for 3 min. Calculate the energy dissipated through it as a result.
2. Magnetic flux associated with a loop is given by $\phi(t) = 15\cos\left(\pi t + \frac{\pi}{4}\right)$, where all the quantities are measured in SI. What will be the magnitude of induced *emf* in it at $3\,s$?

Q. 3. A. Attempt <u>any one</u> of the following. **(07)**

1. Prove that in the presence of matter, Faraday's law gets modified to $\vec{\nabla} \cdot \vec{D} = \rho_f$.
2. Taking an example of charging of a capacitor, show that the divergence of curl of magnetic field is not zero.

B. Solve <u>any one</u> of the following. **(03)**

1. A parallel plate capacitor of capacitance 2200 μF is connected to a 50 V power supply. The length of each of its square plates is 0.4 cm. Calculate
   i. Charge deposited on its plates and
   ii. The magnitude of electric field between the two plates.
   ($\in_o = 8.85 \times 10^{-12}\ SI$)
2. Electric field in an electromagnetic wave is given by

   $$E = 5 \cos 3\pi\,(3 \times 10^{10} t - 10^2 x)$$

   where all the quantities are in SI units. Find
   i. wavelength,
   ii. frequency and
   iii. speed of this wave.

Q. 4. A. Attempt <u>any one</u> of the following. **(07)**

1. Consider a linearly polarized electromagnetic wave to be incident normally at the interface of two lossless dielectrics. State expressions for electric field and magnetic field corresponding to the incident wave, transmitted wave and reflected wave. Show that the reflectivity of the surface is given by

   $$R = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2$$

2. Consider a plane polarized electromagnetic wave incident on an interface of two media. Prove that the frequencies of the transmitted wave and the reflected wave are the same as that of the incident wave.

B. Solve <u>any one</u> of the following. **(03)**

1. Calculate the phase shift for the reflection by glass-air interface ($n_{glass} = 1.68$, $n_{air} = 1$) when the angle of incidence is 45°.
2. A ray of light goes from air ($n = 1$) to glass ($n = 1.56$). Determine its reflectivity and transmittivity.

Q. 5. A. Attempt <u>any one</u> of the following. **(07)**

1. What is total internal reflection?
   Why glass fibers are preferred as optical fibers?
2. Define waveguide parameter and discuss its variation with respect to the wavelength of the signal.

B. Solve <u>any one</u> of the following. **(03)**

1. Find critical angles for
   i. air-water interface,
   ii. water-glass interface and
   iii air-glass interface.
   ($n_{air} = 1$, $n_{water} = 1.33$, $n_{glass} = 1.65$)
2. The refractive index of the core and the cladding of an optical fibre are 1.60 and 1.55 respectively. Find its numerical aperture and the maximum angle of incidence for which total internal reflection is possible.