

2103000206021002
EXAMINATION FEBRUARY-MARCH 2024
BACHELOR OF SCIENCE (SIXTH SEMESTER)
PHYSICS PAPER - VII (PH-607-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 (SIXTH SEMESTER)**
- b. Name of the Subject: **PHYSICS PAPER - VII (PH-607-ELECTRODYNAMICS AND OPTICS) - LEVEL 2**
- c. Subject Code No: **2103000206021002**

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 any ten in brief.

10

1. State Ohm's law.
2. The conductivity of a wire of length 50 cm and diameter 2 mm is $5.6 \times 10^7 \text{ } \Omega\text{-m}^{-1}$. What will it be for a wire of length 1m and diameter 1 mm of the same material?
3. Give dimensional formula of *emf*.
4. According to Faraday's law of electromagnetic induction, time varying magnetic field gives rise to _____.
5. Divergence of curl of electric field is always zero. Agreed?
6. State Ampere-Maxwell's law.
7. State boundary condition for the field \vec{H} across an interface of two media.
8. Define: Refraction of light.
9. Which property of the wave does not change when it is reflected by a rigid support?

10. The output is one-tenth of the input from an optical fiber. What will be the value of loss in dB?
11. When white light is coupled into a long fibre, ____ colour is scattered the most.
12. State the condition(s) to be satisfied for total internal reflection to take place.

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

7

1. Suppose there are n molecules per unit volume and f free electrons per molecule, each with charge q and mass m . Prove that the current density is given by

$$\vec{J} = \left(\frac{nf\lambda q^2}{2mv_{thermal}} \right) \vec{E}$$

2. What is self-induction? Derive an expression for self- induced emf .

(B) Solve any one of the following.

3

1. A battery of potential difference 150 V is connected to a 67 k Ω resistor. If the current is allowed to pass through it for 5 min, how much energy is radiated by it in the form of heat as a result?
2. Find the self-inductance of a toroidal coil having rectangular cross section (of inner radius a , outer radius b and height h), which carries a total of N turns.

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

7

1. Prove that in the presence of matter, Ampere's law gets modified to

$$\vec{\nabla} \times \vec{D} = \vec{J}_f + \frac{\partial \vec{D}}{\partial t}.$$
2. State an expression for Poynting's theorem and give interpretation of each term appearing in it.

(B) Solve any one of the following.

3

1. Electric field in an electromagnetic wave is given by

$$E = 2 \cos \pi (9 \times 10^{10}t + 300x)$$

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

2. State an expression for Poynting's vector and derive its unit. Its unit is equivalent to one of the properties of light. Which is that property?

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

7

1. Consider a plane polarized electromagnetic wave incident on an interface of two media. State and prove laws of reflection.
2. Consider an electromagnetic wave incident obliquely on the interface of two media. Derive Brewster's law using the fact that at the polarizing angle, the angle between the reflected wave and the refracted wave is 90° .

(B) Solve any one of the following.

3

1. A ray of light goes from air ($n = 1$) to glass ($n = 1.5$). Find the angle of incidence for which the reflected ray becomes completely polarized. Also calculate it when the ray of light goes from water ($n = \frac{4}{3}$) to glass ($n = 1.5$).
2. A ray of light goes from water ($n = \frac{4}{3}$) to glass ($n = 1.65$) normally. Find the values of reflectivity and transmittivity of the surface.

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

7

1. What is cladding? Compare its refractive index with that of the core. Why is it required to have cladded fiber?
2. Define waveguide parameter and discuss its variation with respect to the wavelength of the signal.

(B) Solve any one of the following.

3

1. The power of a 5 mW laser beam decreases to $30 \mu\text{W}$ after traversing through 50 km of an optical fibre. Find the attenuation of the fibre in $\frac{\text{dB}}{\text{km}}$.
2. The refractive index of the core and the cladding of an optical fibre are 1.50 and 1.46 respectively. Find its numerical aperture and the maximum angle of incidence for which TIR is possible.
