RAN-2103000206021002

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B.Sc. (Sem. VI) Examination September - 2023

Physics : Paper - VII - PH-607 : 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. VI)**

Name of the Subject :

☛ **Physics : Paper - VII - PH-607 : Electrodynamics and Optics**

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 any ten in brief. (10)

1. State Ohm's law.
2. Give unit of magnetic flux.
3. What is mutual induction?
4. Define: henry.
5. Which of the Maxwell's equations show that the magnetic monopole does not exist?
6. State boundary condition for the parallel component of electric field $\vec{E}$ across an interface of two media.
7. State any one law of refraction.
8. The intrinsic impedance of a medium (η) is related to its refractive index (n) by the equation _____.
9. The resistivity of a wire of length 50 *cm* and diameter 2 *mm* is 1.8×10^{-8} Ωm. What will it be for a wire of length 1 *m* and diameter 1 *mm*?

10. The output is one-tenth of the input from an optical fiber. What will be the value of loss in dB?
11. Which factors determine the information carrying capacity of a fiber-optic system?
12. What is the principle of periscope?

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

1. Name the forces involved in driving current around a circuit and explain their role. From that, establish the definition of *emf*. What is the unit of *emf*?
2. State and explain Faraday's law of electromagnetic induction. Derive its integral form.

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

1. Two long cylinders (radii a and b) are separated by material of conductivity σ. If they are maintained at a potential difference V, what current flows from one cylinder to the other, in a length L?
2. Derive following expression for the energy stored in magnetic field in the case of an inductor

$$U = \frac{1}{2} LI^2$$

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

1. Define electrostatic potential, write down its equation and give its unit. For an ideal source, show that the potential difference between two terminals of a battery is equal to its *emf*.
2. Prove that the rate at which work is done on all the charges in the given volume is given by

$$\frac{dW}{dt} = \int_v (\vec{E} \cdot \vec{J})\, d\tau.$$

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

1. A parallel plate capacitor of capacitance 2200 μF is connected to a 100 V power supply. The plates are square having side 0.5 cm.
   Calculate (i) charge deposited on its plates and (ii) the magnitude of electric field between its plates. ($\in_o = 8.85 \times 10^{-12}$ SI).
2. Electric field in an electromagnetic wave is given by
   $E = 4 \cos 2\pi (3 \times 10^{12} t + 10^4 x)$ where all the quantities are in SI units.
   Find (i) wavelength, (ii) frequency and (ii) speed of this wave.

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

1. 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 same as that of the incident wave.
2. 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 Transmittivity of the surface is given by

$$T = \frac{4n_1 n_2}{(n_1 + n_2)^2}$$

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

1. A ray of light goes from air ($n = 1$) to glass ($n = 1.6$). Find the angle of incidence for which the reflected ray becomes completely polarized. Also calculate it when the ray of light goes from water $\left(n = \frac{4}{3}\right)$ to glass ($n = 1.6$).
2. A ray of light goes from air ($n = 1$) to glass ($n = 1.5$). Determine its reflectivity and transmittivity.

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

1. Discuss the use of coherent bundle during endoscopy.
2. Why glass fibers are preferred as optical fibers? Why is it required to have cladded fiber?

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

1. Find critical angles for (i) air-water interface, (ii) water-glass interface and (iii) air-glass interface.
$\left(n_{air} = 1, n_{water} = \frac{4}{3}, n_{glass} = 1.5\right)$

2. The refractive index of the core and the cladding of an optical fibre are 1.475 and 1.450 respectively. Find its numerical aperture and the maximum angle of incidence for which TIR is possible.

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