RAN-2103000206021002

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

Physics Paper - VII (PH - 607) New Course

(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) New Course (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: electric current.
2. What are the sources of magnetic field?
3. Divergence of curl of electric field is always zero. Agreed?
4. What does the minus sign indicate in Faraday's law of electromagnetic induction?
5. The term added by Maxwell in the Ampere's law is called _____.
6. State boundary condition for the perpendicular component of field $\vec{B}$ across an interface of two media.
7. What is the dimensional formula of amplitude transmission coefficient?

8. The refractive index of a medium is 1.5. What will be its intrinsic impedance? (Intrinsic impedance of vacuum is $120\pi\Omega$)

9. A current of 2 *A* is passed through a coil and as a result, the amount of magnetic flux linked with it is 4 *SI*. Now, if the current is doubled, the magnetic flux linked with it will become _____.

10. The output is one-hundredth 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. State the condition(s) to be satisfied for total internal reflection to take place.

Q.2 (A) Attempt <u>any one</u> of the following. **(7)**

1. What is motional *emf*? 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. Show that when this loop is pulled out of the magnetic field with velocity $\vec{v}$, the induced *emf* in it given by $\varepsilon = Bvh$, where *h* is the separation between the two arms of the loop in the magnetic field.

2. What is Neumann's formula? Show that $M_{12} = M_{21}$.

(B) Solve <u>any one</u> of the following. **(3)**

1. A plane is flying at a constant speed of 900 *kmph* towards west. As a result, how much *emf* will be induced between the endpoints of its wings which are at a separation of 8 *m*? (The horizontal component of geo-magnetic field at the given place is 0.36 *G*).

2. A short solenoid (of length *l*, radius *a* and having n_1 turns per unit length) lies on the axis of a very long solenoid (of radius *b* and having n_2 turns per unit length). Current *I* flows in the short solenoid. What is the flux through the long solenoid?

Q.3 (A) Attempt <u>any one</u> of the following. **(7)**

1. Show that polarization current density is given by

$$\vec{J}_P = \frac{\partial \vec{P}}{\partial t}$$

2. The rate at which work is done on all the charges, in the given volume, is given by

$$\frac{dW}{dt} = -\frac{d}{dt}\int_V \frac{1}{2}\left[\epsilon_0 E^2 + \frac{B^2}{\mu_0}\right] d\tau - \int_V \vec{\nabla}.(\vec{E} \times \vec{B})\, d\tau$$

Give interpretation of the terms appearing on the RHS of this equation.

(B) Solve <u>any one</u> of the following. **(3)**

1. Prove that the unit and dimensional formula of $\frac{E}{B}$ are the same as those of the speed.

2. Electric field in an electromagnetic wave is given by

$$E = cos\pi\,(3 \times 10^{10}\, t + 100x)$$

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. **(7)**

1. Consider a linearly polarized electromagnetic wave to be incident normally at the interface of two media. Obtain expressions for electric field and magnetic field corresponding to the incident wave, transmitted wave and reflected wave

2. Consider an electromagnetic wave to be incident normally on a perfect conductor. Show that the transmission coefficient of the surface is given by

$$t = \frac{2(1-i)h}{1+(1-i)h}$$

(B) Solve <u>any one</u> of the following. **(3)**

1. Calculate the phase shift for the reflection by glass-air interface ($n_{glass} = 1.5, n_{air} = 1$) when the angle of incidence is 60°.

2. A ray of light goes from water ($n = 4/3$) to glass ($n = 1.72$) normally. Find the values of reflectivity and transmittivity of the surface.

Q.5 (A) Attempt <u>any one</u> of the following. **(7)**

1. Discuss the factors responsible for attenuation in optical fibers.

2. What is numerical aperture of an optical fiber?
   Derive its expression.

(B) Solve <u>any one</u> of the following. **(3)**

1. The power of a 5 mW laser beam decreases to 30 μW after traversing through 40 km of an optical fibre. Find the attenuation of the fibre in $\frac{dB}{km}$.

2. The refractive index of the core and the cladding of an optical fibre are 1.465 and 1.450 respectively. Find its numerical aperture and the maximum angle of incidence for which TIR is possible.

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