BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSc **SEMESTER : VI**
BRANCH: PHYSICS **SESSION : SP/2023**

SUBJECT: PH315 ELECTROMAGNETIC THEORY

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Write the five vector identities that were utilized to understand the electromagnetic theory phenomena during the course of study.	[5]	1	1
Q.1(b)	Fig. 1. shows the incidence of plane electromagnetic wave on an interface between two different media. The symbols appearing in the image has their usual meanings.	[5]	1	3

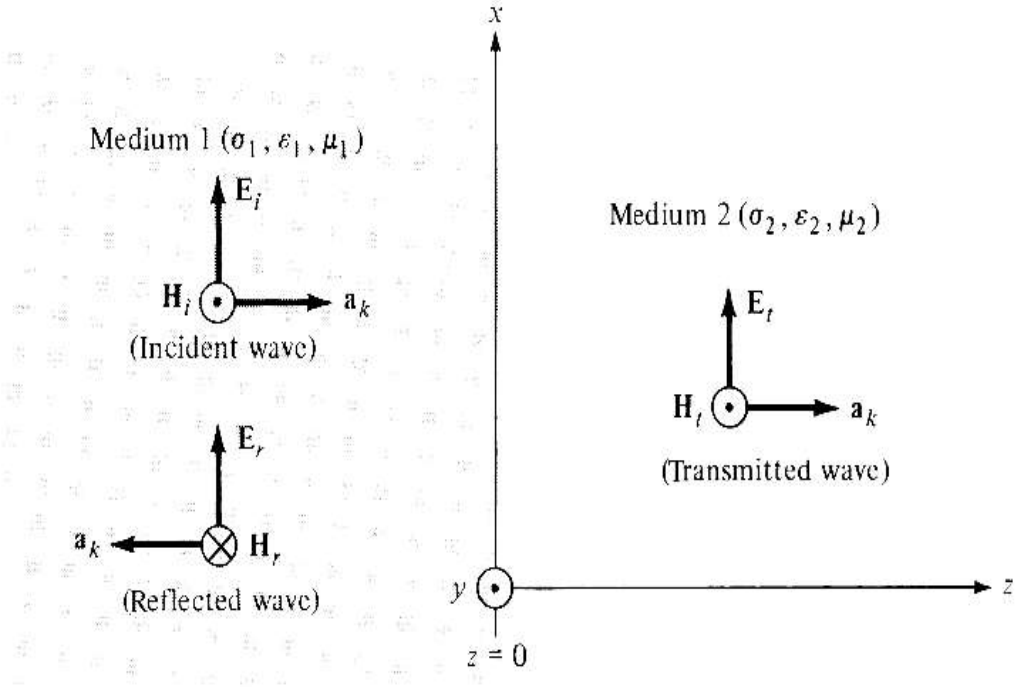

Fig. 1. Electromagnetic wave incidence at boundary.

Considering γ_1 and γ_2 to be propagation constants in them medium 1 and medium, respectively; Write the mathematical expressions (phasor forms) for the following cases:

(I) Incident electric field.
(II) Reflected electric field.
(III) Transmitted electric field.
(IV) Incident magnetic field.
(V) Reflected magnetic field.

PTO

Q.2(a)	Light is the manifestation of an electromagnetic wave. Prove this manifestation mathematically utilizing the concepts of electromagnetic theory.	[5]	2	5
Q.2(b)	The existence of fields in a region consisting of two different media, the conditions that the field must satisfy at the interface separating the media are called *boundary conditions*. Analyse such boundary conditions for electrostatic and electromagnetic fields.	[5]	2	3
Q.3(a)	Refer to Fig.1. and utilizing the phasor form of electric and magnetic fields, show that the time average (ave) incident Poynting vector in the medium 1 corresponds to $P_{ave}(z) = \frac{E_{i0}^2}{2\lvert\eta_1\rvert} e^{-2\alpha_1 z} cos\theta_{\eta_1} \hat{z}$ Where α_1 is the attenuation constant	[5]	3	5
Q.3(b)	Refer to Fig. 1 and consider lossless media where $\eta_2 > \eta_1$. In medium 1 the incident and reflected waves have unequal amplitudes. What kind of wave the incident and reflected wave will interfere to produce? Show that the relative maxima and minima of $\lvert E_1 \rvert$ occurs at $z_{max} = -\frac{n\pi}{\beta_1}$ and $z_{min} = -\frac{(2n+1)\pi}{2\beta_1}$, respectively; where β_1 corresponds to phase constant in medium 1 and $n = 0, 1, 2, 3, \ldots$	[5]	3	5
Q.4(a)	Define plasma and obtain the expression of plasma frequency utilizing the concept of perturbation and linearization techniques. Also, obtain the dispersion relation of electron plasma wave and electromagnetic wave in plasmas.	[5]	4	3
Q.4(b)	Discuss the fundamentals of transverse electric (TE) and transverse magnetic (TM) modes propagation of an electromagnetic waves in rectangular waveguide.	[5]	4	3
Q.5(a)	Define polarization and discuss three types of polarization with mathematical conditions. Determine the polarization of a plane wave having following expressions: $\vec{E}(z,t) = 4e^{-0.25z} cos(\omega t - 0.8z)\hat{a}_x + 3e^{-0.5z} sin(\omega t - 0.8z)\hat{a}_y \text{ V/m}$	[5]	5	2
Q.5(b)	Define optical fiber and its principle of working. What is the role of numerical aperture with respect to designing of optical fiber? Differentiate step-indexed and graded-indexed optical fiber.	[5]	5	2

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