WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2022

PHSACOR13T-PHYSICS (CC13)

Time Allotted: 2 Hours   Full Marks: 40

The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.

Question No. 1 is compulsory and any *two* questions from the rest

1.   Answer any *ten* questions from the following: $2 \times 10 = 20$

(a) Show that for a good conductor, the phase lag of $\vec{H}$ behind $\vec{E}$ is $\frac{\pi}{4}$.

(b) The intensity of the sunlight reaching the earth's surface is about 1300 W/m^2. Calculate the strength of the electric field of the incoming sunlight.

(c) Find out the dimension of Poynting Vector $\vec{S}$.

(d) Show that TEM waves cannot occur in hollow wave guide.

(e) What are the differences between single mode and multimode fibers?

(f) What are positive and negative crystals?

(g) The conductivity of silver is $3 \times 10^7 \text{mho.m}^{-1}$. Calculate its skin depth at a frequency of 9.5 Hz.

(h) Calculate the thickness of half-wave plate of wavelength 5893Å, Given $n_0 = 1.544$ and $n_e = 1.553$.

(i) The refractive index of the core of an optical fibre is 1.55. What should be the refractive index of the cladding for an acceptance angle of $25°$?

(j) A 20 cm long tube containing sugar solution given a rotation of $10.6°$ of the plane of vibration of a plane polarised light. Find the strength of the solution. Given the specific rotation of sugar = 66.5 $\text{dm}^{-1}\text{g}^{-1}.\text{cm}^{-3}$.

(k) Show that for electromagnetic waves in free space, energy in equally shared between electric and magnetic fields.

(l) Show that the frequency of an electromagnetic wave remains unchanged upon reflection or refraction.

(m) Describe the state of polarization of the electromagnetic wave represented by $\vec{E}(z,t) = \hat{i}\, E_0 \cos(kz - \omega t) - \hat{j}\, E_0 \cos(kz - \omega t)$.

(n) Explain the concept of displacement current.

2. (a) What is Babinet's compensator? Explain, how it can be used to analyse circularly polarized light. 1+3

   (b) When do Maxwell's equation become uncoupled? What is the consequence? 2+1

   (c) Write that the Maxwells' equations for plane polarised electromagnetic waves in a dielectric medium having finite values of μ and ε but $\sigma = 0$ and derive its solution. 3

3. (a) Establish the boundary conditions that must be satisfied by the field vectors. when an electromagnetic wave is incident at the interface between two dielectric media. 3

   (b) Show that the Maxwell's equations are Lorentz invariant. 4

   (c) Define optic axis of a crystal. What is principal section of a crystal? 2+1

4. (a) Write Fresnel's theory of rotation of the plane of polarisation by an optically active substance. 4

   (b) What are H-polaroid and K-polaroid? 3

   (c) An electromagnetic wave polarized perpendicularly to the plane of incidence impinges at 30° on a glass slab having refractive index 1.5. Find the amplitude reflection and transmission coefficients. 3

5. (a) Show that average energy density in a harmonic electromagnetic field is 4
$$\langle u \rangle = \frac{1}{4} \operatorname{Re}[\vec{E} \cdot \vec{D}^* + \vec{H} \cdot \vec{B}^*],$$
   where $\vec{D}^*$ and $\vec{B}^*$ are complex conjugates of $\vec{D}$ and $\vec{B}$.

   (b) Light is incident from air on a glass of refractive index 1.5. Calculate Brewster's angle. 2

   (c) Compute the thickness of quarter wave plate for negative crystal. 2

   (d) Describe with necessary diagram, the step index and graded index optical fibre. 2

   N.B. : *Students have to complete submission of their Answer Scripts through E-mail / Whatsapp to their own respective colleges on the same day / date of examination within 1 hour after end of exam. University / College authorities will not be held responsible for wrong submission (at in proper address). Students are strongly advised not to submit multiple copies of the same answer script.*

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