2017

(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(Pre-Revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* Give the statement of Faraday's laws of electromagnet. 1

(b) Starting from Maxwell's equations, show that the electric field satisfies the following differential equation in a homogeneous medium containing charges and currents :

$$^2\vec{E} \quad \frac{^2\vec{E}}{t^2} \quad \frac{\vec{E}}{t}$$

Here the notations in the equation have their usual meanings. 3

(c) What is displacement current? Prove that the displacement current in the direction of a parallel-plate capacitor is equal to the conduction current in the connecting loads. 1+2=3

Or

(a) Derive the Maxwell's equation

$$\rightarrow \quad \vec{H} \quad \vec{J} \quad \frac{\vec{D}}{t}$$

where $\vec{D}$ is electric displacement and $\vec{J}$ is the current density. 4

(b) Using Maxwell's equations, discuss the boundary conditions satisfied by the magnetic field vector at the interface between two different media. 3

2. *(a)* Derive the general equation for electromagnetic wave equation in free space and hence show that the propagation of electric and magnetic fields are in phase. 2+2=4

(b) Define the transverse nature of electromagnetic waves and explain its orthogonality. 2+1=3

Or

(a) Derive the necessary equation to define the Poynting vector and also explain the Poynting theorem. 2+2=4

(b) Define the electromagnetic momentum and express it in its vector form. 2+1=3

3. *(a)* Discuss the reflection and refraction of electromagnetic wave by considering the oblique incidence at the boundary. 2½+2½=5

(b) Explain in brief the polarization of electromagnetic wave. 2

Or

(a) What is the total internal reflection of an e.m. wave? Show that the wave is totally reflected back at total internal reflection. 3+1=4

(b) What are skin depth and the skin effect in an electromagnetic wave? 3

4. *(a)* What are the scalar and vector potentials in e.m. waves? Show that the electromagnetic potentials satisfy the wave equation. 1+3=4

(b) Derive the Poisson's equation using vector potential with the current density. 3

Or

Discuss the transformation of electromagnetic wave by using Lorentz gauge transformation and explain how the Lorentz gauge is used to explain the wave theory. 4+3=7

5. Deduce the total power radiated from an oscillating dipole

$$\langle P_E \rangle \quad \frac{1}{4 \quad 0} \quad \frac{p_0 \quad ^4}{3c^2}$$

where p_0 is the amplitude of electric dipole, the frequency of oscillating dipole and c the velocity of light 7

Or

Explain Rayleigh scattering of electromagnetic radiation and thus derive the expression for the scattering cross section

$$\frac{\quad ^2}{\quad} \quad T$$
$$0$$

where the symbols used have their usual meanings. 7

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Subject Code : PHY/VI/11 (PR)

Booklet No. A

Date Stamp .....

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To be filled in by the Candidate

DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2017**

Subject .....

Paper .....

INSTRUCTIONS TO CANDIDATES

1. **The Booklet No. of this script should be quoted in the answer script meant for descriptive type questions and vice versa.**
2. **This paper should be ANSWERED FIRST and submitted within** *45 minutes* **of the commencement of the Examination.**
3. **While answering the questions of this booklet, any cutting, erasing, over-writing or furnishing more than one answer is prohibited. Any rough work, if required, should be done only on the main Answer Book. Instructions given in each question should be followed for answering that question only.**

To be filled in by the Candidate

DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2017**

Roll No. .....

Regn. No. .....

Subject .....

Paper .....

Descriptive Type

Booklet No. B .....

Signature of Scrutiniser(s)

Signature of Examiner(s)

Signature of Invigilator(s)

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(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(Pre-Revised)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Put a Tick ☑ mark against the correct answer in the box provided : 1×5=5

1. The integral form of Maxwell's equation originated from Faraday's law of electromagnetic induction is

(a) $\vec{D}\ \bar{d}s \quad {}_{v}dV$ ☐

(b) $\vec{B}\ \bar{d}s \quad 0$ ☐

(c) $\circ_{c} \vec{H}\ \bar{d}l \quad \vec{I}_{c}\ \bar{d}s \quad \frac{\vec{D}}{t}\ \bar{d}s$ ☐

(d) $\circ_{c} \vec{E}\ \bar{d}l \quad \frac{\vec{B}}{t}\ \bar{d}s$ ☐

2. The intrinsic impedance of electromagnetic wave is

(a) $\frac{0}{k}$ ☐

(b) $\frac{_0 k}{}$ ☐

(c) $\frac{0}{k}$ ☐

(d) $\frac{_0 k}{}$ ☐

where the symbols used have their usual meanings.

3. For normal incidence of an e.m. wave from media 1 to 2, the ratio of transmitted intensity to the incidence intensity is

(a) $R_n \quad \frac{n_2 \quad n_1}{n_2 \quad n_1}^{2}$ ☐

(b) $R_n \quad \frac{n_1}{n_2 \quad n_1}^{2}$ ☐

(c) $R_n \quad \frac{n_2 \quad n_1}{n_2 \quad n_1}^{2}$ ☐

(d) $R_n \quad \frac{n_2}{n_2 \quad n_1}^{2}$ ☐

where n_1 and n_2 are the refractive indices of the dielectric media 1 and 2 respectively.

4. For any e.m. wave, the dispersion relation gives the relation between the

(a) wave number k and velocity of the wave v ☐

(b) wave number k and frequency ☐

(c) velocity of the wave v and intensity i ☐

(d) wave number k and intensity i ☐

5. The energy radiated by an oscillating electric dipole is represented by

(a) $\vec{S} \quad \frac{1}{0}(\vec{E} \quad \vec{B})$ ☐

(b) $\vec{S} \quad \frac{1}{}(\vec{E} \quad \vec{B})$ ☐

(c) $\vec{S} \quad \frac{1}{}(\vec{E} \quad \vec{B})$ ☐

(d) $\vec{S} \quad \frac{1}{0}(\vec{E} \quad \vec{B})$ ☐

SECTION—II

(*Marks* : 15)

Give very short answers to the following questions : 3×5=15

1. If e.m. wave is propagated in a material media, show that the Maxwell's equations for curl B becomes

$$\nabla \times \vec{B} = \vec{J}_f + \nabla \times \vec{M} + \frac{\partial \vec{P}}{\partial t} + \frac{1}{c^2}\frac{\partial \vec{E}}{\partial t}$$

where the notations in the equation have their usual meanings.

2. Define the radiation pressure and give the relation with intensity of e.m. wave.

3. State and explain Brewster's law in electromagnetic waves.

4. Explain the non-uniqueness of the magnetic and scalar potentials.

5. What are retarded potentials and retarded times in an electromagnetic wave?

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