2016

(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* Write down the statement of boundary condition for e.m. wave in two different media. 2

(b) Deduce an expression for the energy stored in an inductor carrying a current. Hence find an expression for the energy density in a magnetic field. 2+3=5

Or

Derive Maxwell's first electromagnetic equation. What will be its form for free space and a dielectric medium? 5+1+1=7

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2. Use Maxwell's electromagnetic equations to derive the wave equations satisfied by the electric field vector $\vec{E}$ and the magnetic field vector $\vec{B}$ in free space. Obtain their plane wave solutions. Establish the transverse nature of electromagnetic waves. 3+2+2=7

Or

Define Poynting vector. State and prove Poynting theorem. 2+1+4=7

3. Discuss reflection and refraction of electromagnetic wave for oblique incidence at the boundary between two linear dielectric media. 7

Or

(a) Starting from Maxwell's electromagnetic equations, show that an electromagnetic wave is damped inside a conducting medium. 4

(b) State and explain Brewster's law in electromagnetic waves. 1+2=3

4. Explain electromagnetic scalar and vector potentials. Discuss their non-uniqueness. What do you understand by gauge transformation? 3+3+1=7

Or

Explain Coulomb gauge and Lorentz gauge conditions. Use Lorentz gauge to deduce the Poisson's equations satisfied by the electromagnetic potentials in non-static conditions. Comment on these equations for static conditions. 3+3+1=7

5. Show that the total power radiated from an oscillating electric dipole in free space is

$$\langle P \rangle \quad \frac{p_0^2 \quad ^4}{12 \quad _0 c^3}$$

where p_0 is the amplitude of the oscillating dipole moment, is its angular frequency, $_0$ is the permittivity of free space and c is the speed of light in free space. 7

Or

Give Lorentz theory of dispersion of electromagnetic waves. Discuss normal and anomalous dispersions. 5+2=7

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Subject Code : PHY/VI/11

Booklet No. A

Date Stamp .....

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To be filled in by the Candidate

DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....

Paper .....

To be filled in by the Candidate

DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Roll No. .....

Regn. No. .....

Subject .....

Paper .....

Descriptive Type

Booklet No. B .....

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.**

Signature of Scrutiniser(s) *Signature of Examiner(s)* *Signature of Invigilator(s)*

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(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(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 differential form of Ampere's law in magnetostatics is

(a) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{j}$ ☐

(b) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{j}$ ☐

(c) $\vec{\nabla} \times \vec{E} = \frac{\vec{B}}{t}$ ☐

(d) $\vec{\nabla} \times \vec{E} = -\frac{\vec{B}}{t}$ ☐

where notations stand for their usual meanings.

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2. The speed of light in free space is

(a) $\frac{1}{\sqrt{0\ 0}}$ ☐

(b) $\sqrt{0\ 0}$ ☐

(c) $\sqrt{\frac{0}{0}}$ ☐

(d) $\sqrt{\frac{0}{0}}$ ☐

3. An unpolarized electromagnetic wave travelling in air is incident on the surface of a transparent dielectric medium. If the angle of incidence is equal to the Brewster's angle of the wave for the medium, then the angle between the reflected and refracted parts of the wave is

(a) 60° ☐

(b) 30° ☐

(c) 90° ☐

(d) 45° ☐

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4. If the vector and scalar potentials in a region of space are respectively $\vec{A}$ and V, then the magnetic field there exists is

(a) $\vec{A}$ ☐

(b) V ☐

(c) $\vec{A}$ V ☐

(d) $\vec{A}$ V ☐

5. For a TE wave inside a waveguide, the magnetic field vector $\vec{B}$ can be represented as

(a) $\vec{B}$ $\hat{i}B_x$ $\hat{j}B_y$ $\hat{k}B_z$ ☐

(b) $\vec{B}$ $\hat{i}B_x$ $\hat{j}B_y$ ☐

(c) $\vec{B}$ $\hat{i}B_x$ $\hat{k}B_z$ ☐

(d) $\vec{B}$ $\hat{j}B_y$ $\hat{k}B_z$ ☐

where notations stand for their usual meanings.

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SECTION—II

(*Marks* : 15)

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

1. Explain what you mean by displacement current.

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2. Define radiation pressure and write down its expression for a perfect absorber and a perfect reflector of electromagnetic radiation in terms of its intensity.

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3. Calculate the skin depth for an electromagnetic wave of wavelength 3 m (in free space) in a conducting medium of conductivity $6 \quad 10^{7} \quad {}^{1}\,m^{1}$ and permeability $4 \quad 10^{7}$ H/m.

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4. Express the Lorentz force equation in terms of the scalar and vector potentials of electromagnetic field.

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5. What is Rayleigh scattering?

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