2017

(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(Revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. Using Maxwell's electromagnetic field equations, deduce the wave equations satisfied by the electric field vector and the magnetic field vector in free space. Obtain their plane wave solution and hence show that electromagnetic waves are transverse in nature. 3+2+2=7

Or

Define Poynting vector. Deduce theoretically Poynting theorem for the flow of energy in an electromagnetic field. 2+5=7

2. Derive Fresnel equations for reflection and refraction of electromagnetic waves at a plane boundary separating two media when the incident wave is polarized with *E* vector parallel to the plane of incidence. Find the angle of incidence for which there is no reflected wave. What is this angle called? 5+1+1=7

Or

Discuss the propagation of plane electromagnetic waves in conducting medium and hence explain why plane wave cannot propagate in it without attenuation. 6+1=7

3. What are the electromagnetic potentials? Establish the non-uniqueness of electromagnetic potentials. What do you mean by gauge transformation? 3+3+1=7

Or

What do you mean by Coulomb gauge and Lorentz gauge? Show that the scalar potential satisfies Poisson's equation and hence explain the origin of transverse gauge. 3+3+1=7

4. *(a)* Draw the equivalent circuit of an op-amp. Write down the characteristics of an ideal op-amp. 3

(b) Using op-amp, design an inverting amplifier and obtain the expression for voltage gain. 4

Or

Draw the circuit diagram of integrator and differentiator using op-amp. Obtain the expression for output voltage in both the cases. 3+2+2=7

5. *(a)* What are universal gates and why are they so called? Draw their logic symbols and write their truth table. 1+3=4

(b) Construct a logic circuit whose output is given by the Boolean expression $(A \quad B)\ \overline{AB}$. 3

Or

(a) State and prove De Morgan's theorem. 3

(b) Write the truth table and draw the digital circuit of full adder. 4

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Subject Code : PHY/VI/11 (R)

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)

(Revised)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Tick (✓) the correct answer in the brackets provided : 1×5=5

1. For a plane wave of angular frequency ω and propagation vector $\vec{k}$ propagating in the medium, Maxwell's equations reduce to

(a) $\vec{k}\cdot\vec{E}=0,\ \vec{k}\cdot\vec{H}=0,\quad \vec{k}\times\vec{E}=-\mu\omega\vec{H},\ \vec{k}\times\vec{H}=\varepsilon\omega\vec{H}$ ( )

(b) $\vec{k}\cdot\vec{E}=0,\ \vec{k}\cdot\vec{H}=0,\quad \vec{k}\times\vec{E}=\mu\omega\vec{H},\ \vec{k}\times\vec{H}=\varepsilon\omega\vec{H}$ ( )

(c) $\vec{k}\cdot\vec{E}=0,\ \vec{k}\cdot\vec{H}=0,\quad \vec{k}\times\vec{E}=\varepsilon\omega\vec{H},\ \vec{k}\times\vec{H}=-\mu\omega\vec{H}$ ( )

(d) $\vec{k}\cdot\vec{E}=0,\ \vec{k}\cdot\vec{H}=0,\quad \vec{k}\times\vec{E}=\mu\omega\vec{H},\ \vec{k}\times\vec{H}=-\varepsilon\omega\vec{H}$ ( )

2. When a plane electromagnetic wave enters from one medium into another, which of the following quantity remains unchanged?

(a) Frequency ( )

(b) Electric field amplitude ( )

(c) Wavelength ( )

(d) Velocity ( )

3. Unlike electrostatics in electrodynamics, we cannot write

(a) $\vec{B} = \vec{\nabla} \times \vec{A}$ ( )

(b) $\vec{\nabla} \times \vec{E} = 0$ ( )

(c) $\vec{\nabla} \times \vec{E} \neq 0$ ( )

(d) $\vec{\nabla} \cdot \vec{B} = 0$ ( )

4. The common mode rejection ratio of an ideal diff-amp is

(a) zero ( )

(b) infinity ( )

(c) less than unity ( )

(d) greater than unity ( )

5. The 2's complement of 1000_2 is

(a) 0111 ( )

(b) 0101 ( )

(c) 1000 ( )

(d) 0001 ( )

SECTION—II

(*Marks* : 15)

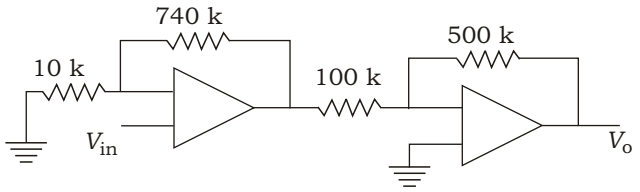
Give very short answers to the following questions : 3×5=15

1. What do you mean by momentum and radiation pressure of an electromagnetic wave?

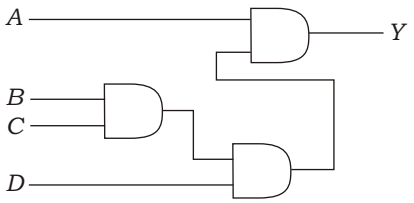
2. The constitutive parameters of aluminium are given by $\mu_r = 1$, $\varepsilon_r = 1$, $\mu_0 = 4\pi \times 10^{-7}$ H/m and $\sigma = 3 \cdot 54 \times 10^7$ mho/m. Find the frequency for which the skin depth of aluminium is 0·01 mm.

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

4. Find the output of the circuit given below :



5. After finding the Boolean equation for the circuit shown in the figure below, compute the output if $A = 1,\ B = 0,\ C = 1,\ D = 0$:



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