

2017

(CBCS)

(3rd Semester)

PHYSICS

THIRD PAPER

(Electromagnetism and Optics)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(Marks : 50)

*The figures in the margin indicate full marks
for the questions*

1. (a) A parallel-plate capacitor with distance between the plates d , area of the plate A is filled with dielectric slab of dielectric constant K and thickness t . Show that its capacitance is

$$C = \frac{\epsilon_0 A}{d} \left(1 + \frac{t}{K} \right)$$

When the dielectric slab is replaced with metal, find the expression of C . 5+2=7

- (b) Obtain the expression for force per unit area on the surface of a conductor in electric field. 3

Or

- (a) Using Gauss' theorem, obtain the following expressions for electric charge due to solid sphere of radius R and charge Q : 3+4=7
- (i) Outside the sphere
- (ii) Inside the sphere
- (b) Calculate the number of electric lines of force originating from a charge of 1C. 3

2. (a) State and prove Thevenin's theorem. 1+6=7

- (b) Write down the continuity equation for electric current stating its physical interpretation. 3

Or

- (a) For a series resonant circuit containing resistance R , self-inductance L and capacitance C , (i) derive the expression for current at any instant and (ii) derive the condition of resonance. 5+2=7
- (b) What do you mean by Q -factor? What does it measure? 3

(3)

3. (a) Using Ampere's circuital law, calculate magnetic field (i) inside a hollow straight conductor carrying current and (ii) inside a solid straight conductor of radius R carrying current. 3+4=7
- (b) Derive the expression for force on a straight conductor carrying current placed in uniform magnetic field. 3

Or

Write down the statement of Faraday's law of electromagnetic induction. Obtain its integral and differential forms. 1+4+5=10

4. (a) Show that the condition for constructive interference is $2n\lambda$, where λ is phase difference between the two light waves and n is positive integer. 4
- (b) Obtain the positions for bright fringe and dark fringe and hence the expression for fringe width. 6

Or

- (a) Discuss the theory of Newton's ring. How can wavelength of the light be determined with the help of Newton's ring? 7
- (b) What is Faraday's effect? 3

(4)

5. (a) Discuss diffraction at a single slit. Obtain the positions for minima and hence the expression for fringe width. 7
- (b) What do you mean by Fresnel's half-period zone? 3

Or

- (a) Obtain the expression for resolving power of a prism. 7
- (b) Explain in brief Rayleigh criterion for resolution of object. 3

Subject Code : PHY/III/EC/05

Booklet No. A

Date Stamp

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To be filled in by the Candidate

CBCS
DEGREE 3rd 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 **1 (one) Hour** 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

CBCS
DEGREE 3rd Semester
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Roll No.
Regn. No.
Subject
Paper
Descriptive Type
Booklet No. B

Signature of
Scrutiniser(s)

Signature of
Examiner(s)

Signature of
Invigilator(s)

/49

PHY/III/EC/05

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(CBCS)

(3rd Semester)

PHYSICS

THIRD PAPER

(Electromagnetism and Optics)

(PART : A—OBJECTIVE)

(Marks : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(Marks : 10)

Put a Tick (✓) mark against the correct answer in the
brackets provided : 1×10=10

1. Energy stored in capacitor is in the form of

- (a) electrical energy ()
- (b) magnetic energy ()
- (c) both electrical energy and magnetic energy ()
- (d) Any form of energy ()

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(2)

2. In a polarized dielectric, the relation between polarization vector, the displacement vector and electric field is

(a) $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$ ()

(b) $\vec{P} = \epsilon_0 \vec{E} + \vec{D}$ ()

(c) $\vec{P} = \epsilon_0 (\vec{E} + \vec{D})$ ()

(d) $\vec{D} = \epsilon_0 (\vec{E} + \vec{P})$ ()

3. Kirchhoff's first law is based on the principle of

(a) conservation of energy ()

(b) conservation of charge ()

(c) conservation of momentum ()

(d) conservation of mass ()

4. Power factor of a circuit containing resistance of 10 ohm and impedance of 20 ohm is

(a) 1 ()

(b) 0.2 ()

(c) 0.75 ()

(d) 0.5 ()

(3)

5. A proton from cosmic ray enters normally to the earth's magnetic field. It suffers deflection towards
- (a) East ()
 - (b) West ()
 - (c) North ()
 - (d) South ()
6. When viewed from North pole, direction of current in the core of the earth would be
- (a) clockwise ()
 - (b) anti-clockwise ()
 - (c) vertical ()
 - (d) straight line towards the East ()
7. In Young's double slit experiment (YDSE), if the separation between the two slits is reduced to half, then for a constant wavelength and for constant distance between the slits and the screen
- (a) the fringe width will increase by a factor of $\sqrt{2}$ ()
 - (b) the fringe width will increase by a factor of 2 ()
 - (c) the fringe width will decrease by a factor of $\sqrt{2}$ ()
 - (d) the fringe width will decrease by a factor of 2 ()

(4)

8. Which of the following phenomena is not common to sound and light waves?

(a) Interference ()

(b) Diffraction ()

(c) Coherence ()

(d) Polarization ()

9. Resolving power of telescope is

(a) directly proportional to diameter of the aperture (D) ()

(b) inversely proportional to diameter of the aperture (D) ()

(c) independent of diameter of the aperture (D) ()

(d) directly proportional to the square of diameter of the aperture (D) ()

10. Angular width θ of central maximum of a diffraction pattern of a single slit does not depend on

(a) distance between slit and source ()

(b) wavelength of light used ()

(c) width of the slit ()

(d) frequency of light used ()

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(5)

SECTION—II

(Marks : 15)

Answer any *five* of the following questions :

3×5=15

1. Starting from Gauss's theorem in electrostatics, show that $\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$, where \vec{E} is electric field and ρ is charge density.

Or

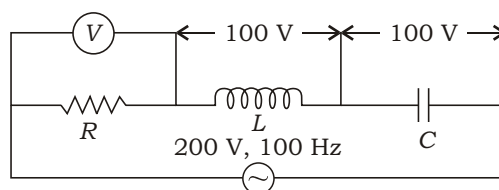
The distance between two plates of a parallel-plate capacitor is d . It is charged to a potential V from a battery, the electric field between the plates is E . Then the battery is disconnected and the distance between the two plates is increased n times. Obtain the new electric field between the plates.

(6)

2. State and explain Kirchhoff's second law. On what principle does the law depend?

Or

In the series L - C - R circuit shown below, calculate the potential difference (reading of voltmeter V) across the resistor R . Is the circuit at resonance?



(7)

3. What do you mean by displacement current? Explain how the concept explains continuity of current in capacitor circuit.

Or

Show that a circular coil carrying current is equivalent to a magnetic dipole.

(8)

4. A light is incident on the glass surface. The reflected light becomes plane polarized. Calculate the polarizing angle and the angle of refraction.

Given :

Refractive index of glass = 1.54

$$\tan^{-1}(1.54) = 57^\circ$$

Or

The ratio of intensity of two light waves is 9 : 4. What is the ratio of maximum to minimum intensity of the two individual waves?

(9)

5. Give the differences between Fresnel diffraction and Fraunhofer diffraction.

Or

What do you mean by limit of resolution? Give its physical interpretation.
