2024

(NEP—2020)

(1st Semester)

PHYSICS (MAJOR/MINOR)

(Electricity Fundamentals)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

(SECTION : A—OBJECTIVE)

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. The current density vector $\vec{J}$ for electron is given by

(a) $\vec{J} = ne\vec{v}$ ( )

(b) $\vec{J} = -ne\vec{v}$ ( )

(c) $\vec{J} = e\vec{v}$ ( )

(d) $\vec{J} = -e\vec{v}$ ( )

2. The equation of continuity $\vec{\nabla} \cdot \vec{J} + \frac{\partial \rho}{\partial t} = 0$ implies

(a) conservation of charge in space ( )

(b) conservation of energy in space ( )

(c) conservation of mass in space ( )

(d) conservation of momentum in space ( )

3. The unit of electrical conductivity is

(a) Ωm ( )

(b) Ωm^{-1} ( )

(c) $\Omega^{-1} m^{-1}$ ( )

(d) $m\Omega^{-1}$ ( )

4. The Lorentz force is given by

(a) $\vec{F} = q\vec{B} + q(\vec{v} \times \vec{E})$ ( )

(b) $\vec{F} = q\vec{E} + q(\vec{v} \times \vec{B})$ ( )

(c) $\vec{F} = v\vec{E} + v(\vec{q} \times \vec{B})$ ( )

(d) $\vec{F} = \vec{E} + q(\vec{v} \times \vec{B})$ ( )

5. The general vector form of Biot and Savart law is

(a) $d\vec{B} = K\frac{i\vec{dl}\times\vec{r}}{r^2}$ ( )

(b) $d\vec{B} = K\frac{i\vec{dl}\times\vec{r}}{r^3}$ ( )

(c) $d\vec{B} = K\frac{i\vec{dl}\times\vec{r}}{r}$ ( )

(d) $d\vec{B} = K\, i\vec{dl}\times\vec{r}$ ( )

6. The direction of induced e.m.f. in a circuit is given by

(a) Faraday's law ( )

(b) Fleming's left-hand rule ( )

(c) Lenz's law ( )

(d) Fleming's right-hand rule ( )

7. The root-mean-square value of AC is

(a) $\frac{2}{\pi}I_0$ ( )

(b) $\frac{\pi}{2}I_0$ ( )

(c) $\frac{I_0}{\sqrt{2}}$ ( )

(d) $\sqrt{2}I_0$ ( )

8. At resonance

(a) $L\omega > \frac{1}{C\omega}$ ( )

(b) $L\omega < \frac{1}{C\omega}$ ( )

(c) $L\omega = \frac{1}{C\omega}$ ( )

(d) $L\omega = C\omega$ ( )

9. The sensitivity of a moving-coil galvanometer cannot be increased

(a) by increasing the number of turns N of the coil ( )

(b) by decreasing the magnetic field B ( )

(c) by increasing the area A of the coil ( )

(d) by decreasing the value of torsion constant k ( )

10. For an ideal voltmeter

(a) resistance should be small ( )

(b) it should be placed in series with the circuit elements ( )

(c) higher the range of voltmeter to be prepared from a given galvanometer, higher is the value of series resistance required for the purpose ( )

(d) the voltmeter of higher resistance has lower resistance than the voltmeter of lower resistance ( )

(SECTION : B—SHORT ANSWERS)

(*Marks* : 15)

Answer *five* questions, taking at least *one* from each Unit : 3×5=15

UNIT—I

1. Define drift velocity and current density. Give the relation between them.

2. What are the limitations and failures of Ohm's law?

UNIT—II

3. Give a brief explanation of Lorentz force.

4. Explain Faraday's law and Lenz's law.

UNIT—III

5. What are mean value and root-mean-square value of an alternating current?

6. Explain the term 'resonance'. What is the condition of resonance in *L-C-R* resonant circuit?

UNIT—IV

7. Deduce the value of shunt resistance *S* required to convert a galvanometer into an ammeter in terms of galvanometer resistance *G* using a neat diagram.

8. Write a brief note on choke coil.

(SECTION : C—DESCRIPTIVE)

(*Marks* : 50)

Answer *five* questions, taking at least *one* from each Unit : 10×5=50

UNIT—I

1. Deduce and discuss the continuity equation. Show that it implies conservation of charge in space. 7+3=10

2. Derive the equations governing the growth and decay of electric current in an *L-R* circuit. What is time constant? 8+2=10

UNIT—II

3. *(a)* State Ampere's law and use it to obtain the expression for the magnetic field due to a current carrying straight conductor of infinite length.

(b) State Biot and Savart law and use it to find the magnetic field due to an infinite straight wire carrying current. 5+5=10

4. What is electromagnetic induction? What is mutual induction? Derive coefficient of mutual induction between two coils. 2+2+6=10

UNIT—III

5. Find the general expression for the power consumed in an AC circuit containing *L-C-R* and hence define power factor and wattless current. 5+3+2=10

6. What are series resonant circuit and parallel resonant circuit? Distinguish between the two. Why is a series resonant circuit known as an acceptor circuit and parallel resonant circuit as rejector circuit? 5+5=10

UNIT—IV

7. What is a moving-coil galvanometer? Describe its principle, construction and working to obtain the formulas for figure of merit and sensitivity. 1+1+2+2+2+2=10

8. Explain the principle, construction and working of AC generator. Give three points of advantages and disadvantages of AC over DC. 2+5+3=10

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