FYUG Even Semester Exam., 2025

PHYSICS

(2nd Semester)

Course No. : PHYDSC–151

(Electricity and Magnetism)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* of the following questions : 2×2=4

(a) What is an electric field line? Why two electric field lines cannot intersect each other? 1+1=2

(b) Derive Poisson's equation from differential form of Gauss' law.

(c) Show that electrostatic field is conservative in nature.

2. Answer any *one* of the following questions :

(a) (i) State and prove Gauss' law. Apply Gauss' law to find the electric field due to a line charge. 1+3+4=8

(ii) Show that the function $\phi = x^2 - y^2 + z$ satisfies Laplace's equation.

(b) (i) What is electric dipole? Define dipole moment. Find the expression for potential and electric field intensity due to an electric dipole. 1+1+5=7

(ii) Find the expression for torque acting on an electric dipole.

UNIT—II

3. Answer any *two* of the following questions : 2×2=4

(a) What are meant by free charge and bound charge? 1+1=2

(b) Write down the relation connecting $\vec{E}$, $\vec{P}$ and $\vec{D}$. What is polarisation vector? 1+1=2

(c) State Gauss' law in dielectrics.

(Continued)

4. Answer any *one* of the following questions : 10

(a) (i) Define electrical susceptibility and dielectric constant. Obtain the relation between them. 1+1+4=6

(ii) Find the expression for capacitance of a parallel plate capacitor with dielectric slab between the plates. 4

(b) (i) Derive an expression for mechanical force per unit area acting on the surface of a charged conductor and hence find the expression for energy density. 3+2=5

(ii) What is electrical image? Using this method of electrical image, obtain the expression for electric field intensity at a point on the plane surface. 2+3=5

UNIT—III

5. Answer any *two* of the following questions : 2×2=4

(a) Define magnetic field. What is the SI unit of magnetic field? 1+1=2

(b) State Biot-Savart law.

(c) What is magnetic Lorentz force?

(Turn Over)

6. Answer any *one* of the following questions :

(a) (i) Using Biot-Savart law, find the expression for magnetic field due to a current carrying circular loop at a point on the axis of the loop.

(ii) Show that $\vec{\nabla} \cdot \vec{B} = 0$. What is its physical significance?

(b) (i) State and prove Ampere's circuital law and show that $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$, where the symbols have their usual meanings. 1+2+3=6

(ii) Explain the equivalence of small current loop as magnetic dipole. What is magnetic dipole moment? 3+1=4

UNIT—IV

7. Answer any *two* of the following questions : 2×2=4

(a) What is meant by neutral temperature and inversion temperature? 1+1=2

(b) Explain Peltier effect.

(c) What is thermoelectric phenomena? Define thermocouple.

(Continued)

8. Answer any *one* of the following questions : 10

(a) Find the expression for e.m.f. in a thermocouple. Explain the law of intermediate temperature and the law of intermediate metals. 4+3+3=10

(b) (i) What is Thomson effect? Explain Thomson coefficient. Also, explain Thomson effect on the basis of free electron theory. 1+2+3=6

(ii) The e.m.f. of a thermocouple, one junction of which is kept at 0 °C, is given by $E = at + bt^2$. Determine the neutral temperature, temperature of inversion and the Peltier and Thomson coefficients. 4

UNIT—V

9. Answer any *two* of the following questions : 2×2=4

(a) State Kirchhoff's laws for a.c. circuits.

(b) State maximum power transfer theorem.

(c) How are quality factor, resonance frequency and bandwidth of an a.c. LCR series circuits related?

(Turn Over)

10. Answer any *one* of the following questions :

(a) What is ballistic galvanometer? Describe the construction and theory of ballistic galvanometer. Explain the current and charge sensitivity of the ballistic galvanometer. State the conditions for a moving coil galvanometer to be ballistic. 1+5+2+2=

(b) (i) State and prove Norton's theorem.

(ii) Find the value of inductance, which should be connected in series with a capacitor of 5 μF, a resistor of resistance 100 ohm and an AC source of 50 cycles per second, so that the power factor is unity.

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