C 21306 (Pages : 3) Name.....

Reg. No.....

FOURTH SEMESTER (CUCBCSS—UG) DEGREE EXAMINATION
APRIL 2022

Physics/Applied Physics

PHY 4B 04/APY 4B 04—ELECTRODYNAMICS—I

(2014—2018 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer **all** *questions.*
Each question carries 1 *mark.*
Answer in a word **or** *phrase.*

1. Write the relationship between electric displacement vector and electric field vector.
2. State Faraday's law of electromagnetic induction. Explain the symbols used.
3. State Coulomb's law in electrostatics.
4. What is the nature of force between two parallel conductors carrying currents ?
5. State Gauss's law for magnetic fields.

State whether the statement is True *or* False

6. For static charge, the curl of E is zero.
7. Below the Curie temperature, a ferromagnetic material would become paramagnetic.
8. H_2O is an example of a polar molecule.
9. For paramagnetic materials, the susceptibility is negative and small.
10. $\nabla^2 V = -\rho/\epsilon_0$ is called Poisson's equation.

(10 × 1 = 10 marks)

Section B

Answer **all** *questions in two* **or** *three sentences.*
Each question carries 2 *marks.*

11. Write down the expression for the work done to assemble a collection of point charges.
12. Write Ampere's law in differential and integral form.

Turn over

13. Derive the relation between electric field and electric potential.
14. Differentiate between susceptibility and permeability.
15. State ampere's force law.
16. Draw a diagram to show the variation of electric field of a charged metallic sphere with distance.
17. Explain scalar potential and vector potential.

(7 × 2 = 14 marks)

Section C

Answer any **five** *questions.*
Each question carries 4 *marks.*

18. Derive the equation $E = -\nabla V$
19. Derive the relation connecting dielectric constant and electric susceptibility.
20. Show that the energy of a magnetic dipole in a magnetic field B is given by $U = -m.B$
21. Derive an expression for the potential of a localized charge distribution.
22. State and explain Gauss's law in the presence of dielectrics.
23. Compare magnetostatics and electrostatics.
24. Explain the magnetostatic boundary conditions.

(5 × 4 = 20 marks)

Section D

Answer any **four** *questions.*

Each question carries 4 *marks*

25. The electric field in some region of space is found to be $E = kr^3 \hat{\mathbf{r}}$ in spherical coordinates, where k is some constant and $\hat{\mathbf{r}}$ is the unit vector. Find the charge density.
26. A conductor 4m. in length lies along the y axis with a current of 10A in the $\hat{y}$ direction. Find the force on the conductor if the field in the region is B = 0.05 tesla in the x direction.
27. A charge 1×10^{-6} C is at the centre of a cubical Gaussian surface of 0.5 mm. edge. What is the electric flux for this surface ?
28. Find the magnetic induction at the centre of a square loop of wire of side '*a*' carrying a current I.

29. A metallic sphere of radius 10 cm. has a surface charge density of 10 nC/m^2. Calculate the energy stored in the system.

30. An all metal aeroplane dives down vertically at 300 km/s where $B_H = 0.4 \times 10^{-4}$T. If the wing span is 30 m, what will be the resulting potential difference between the tips ?

31. A current distribution gives rise to the magnetic vector potential $\mathbf{A} = x^2y\ \hat{x} + y^2x\ \hat{y} - 4xyz\ \hat{z}$. Calculate **B** at (– 1, 2, 5).

(4 × 4 = 16 marks)

Section E

Answer any **two** *questions.*

Each question carries 10 *marks.*

32. Obtain the Gauss's law in differential form. Using Gauss's law, find the electric field inside and outside a spherical shell of radius R that carries a uniform surface charge density σ.

33. (a) State and explain Biot Savart's law.

(b) Derive an expression for the magnetic field due to a circular loop of current at a point on the axis of the coil.

34. (a) Explain atomic polarizability and polarisation vector.

(b) Derive the expression for the torque experienced by a polar molecule (dipole) in a non-uniform field.

35. (a) Derive the expression showing the effect of magnetic field on atomic orbit.

(b) Derive the relation connecting magnetic susceptibility and permeability.

(2 × 10 = 20 marks)