TDC (CBCS) Even Semester Exam., 2023

PHYSICS

(Honours)

(2nd Semester)

Course No. : PHSHCC-201T

(Electricity and Magnetism)

Full Marks : 50

Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—A

Answer any *ten* questions : 2×10=20

1. Define electric field and electric field lines.

2. Give the concept of electric flux.

3. Define electrostatic potential. What do you mean by an electric dipole?

4. State the factors on which the capacitance of a parallel-plate capacitor depends.

5. A spherical conductor of radius 0·2 meter is charged to a potential of 3000 volt. Calculate its surface charge density.

6. What do you you mean by electrical susceptibility and dielectric constant?

7. State Biot-Savart law.

8. What do you mean by magnetic dipole and magnetic dipole moment?

9. What is the physical significance of magnetic vector potential?

10. Define magnetisation vector and magnetic intensity.

11. What do you mean by magnetic susceptibility and magnetic permeability?

12. Explain self induction and mutual induction.

13. What do you mean by power dissipation in a series *LCR* circuit?

14. State Norton theorem.

15. What are the conditions for a moving coil galvanometer to be ballistic?

SECTION—B

Answer any *five* questions : 6×5=30

16. State and prove Gauss' law in electrostatics. By using Gauss' law, prove that the electric field inside a hollow spherical charge distribution is zero. 4+2=6

17. *(a)* Starting from the differential form of Gauss' law in electrostatics, deduce Poisson's and Laplace's equations. 3

(b) Show that the electric potential on the equatorial line of an electric dipole is zero. 3

18. Obtain an expression for the capacitance of an isolated spherical conductor. Show that the total electrostatic energy stored in a parallel-plate capacitor is given by $\frac{1}{2}CV^2$. (Here the symbols have their usual meaning.) 2+4=6

19. *(a)* Derive the relation

$$\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$$

(Here the symbols have their usual meaning.) 3

(b) Obtain Gauss' law as applied to dielectrics in integral and differential forms. 3

20. *(a)* Find the magnetic field due to an infinitely long wire carrying current I at a distance r from it. 3

(b) Obtain an expression for the force acting on a current-carrying conductor placed inside a uniform magnetic field. 3

21. *(a)* Two straight long parallel conductors are carrying currents I_1 and I_2 in the same direction. Derive an expression for the force per unit length between them. 3

(b) Deduce an expression for the torque acting on a current loop placed in a uniform magnetic field. 3

22. *(a)* Establish the relation

$$\vec{B} = \mu_0(\vec{H} + \vec{M})$$

where the symbols have their usual meaning. 3

(b) Show that the hysteresis loss per cycle of magnetisation is equal to the area of the B—H loop. 3

23. *(a)* State Faraday's laws of electromagnetic induction. Show that the Lenz's law is in accordance with the conservation of energy principle. 1+2=3

(b) State and explain the reciprocity theorem. What do you mean by displacement current? 2+1=3

24. *(a)* What do you mean by reactance and impedance? State the phase relation between voltage and current in a series *LCR* circuit. 1+2=3

(b) What do you mean by resonance, quality factor and band width in a series *LCR* circuit? 3

25. *(a)* State and prove maximum power transfer theorem. 3

(b) Discuss the current and charge sensitivity of a ballistic galvanometer. 3

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