2024/FYUG/EVEN/SEM/
PHYDSC–151T/026

FYUG Even Semester Exam., 2024

PHYSICS

(2nd Semester)

Course No. : PHYDSC–151T

(Electricity and Magnetism)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—A

Answer any *ten* of the following questions : 2×10=20

1. What is the unit of electric flux? When do we consider electric flux to be positive and when do we consider it to be negative? 1+1=2

2. State uniqueness theorem.

3. Write down the conditions of stable and unstable equilibrium for a dipole placed in a uniform electric field.

4. Define capacitance. On what factors does capacitance depend? 1+1=2

5. Define dielectric constant of a material. Give two examples of any dielectric material. 1+1=2

6. Define electric displacement vector $\vec{D}$. What types of charges are associated with $\vec{D}$? 1+1=2

7. What is a magnetic dipole? Define dipole moment. 1+1=2

8. What is a toroid? What are toroids used for? 1+1=2

9. Write the expression of torque acting on a current loop placed in a uniform magnetic field. Name all the parameters involved in the above equation. 1+1=2

10. What is thermoelectricity? Mention two applications of Seeback effect. 1+1=2

11. State the law of intermediate temperature. 2

12. Write two differences between Peltier effect and Thomson effect. 2

13. What is meant by impedance and reactance of a.c. circuits? 2

(Continued)

14. What is quality factor? State the relation between Q-factor and bandwidth. 2

15. Define current sensitivity and charge sensitivity of a ballistic galvanometer. 2

SECTION—B

Answer any *five* of the following questions : 10×5=50

16. *(a)* For a uniformly charged sphere of charge density ρ, find the expression of electric field intensity at a point outside the sphere and also at a point inside the sphere in terms of ρ. Also draw the graph showing the variation of E with distance for both the expressions. 4+1=5

(b) An electric field is given by

$$\vec{E} = 6xy\hat{i} + (3x^2 - 3y^2)\hat{j}$$

Find $\vec{\nabla}\cdot\vec{E}$ and $\vec{\nabla}\times\vec{E}$. Is it a possible electrostatic field? 2+2+1=5

17. *(a)* Show that electric field can be expressed as negative gradient of potential. What is the meaning of –ve sign appearing in the equation $\vec{E} = -\vec{\nabla}V$? 5+1=6

(Turn Over)

(b) If the electrostatic potential in a region is expressed as $V = 2x + 3y - z$, obtain the expression of electric field strength.

18. (a) Explain the principle of working of a capacitor.

(b) What is electrical potential energy? Derive an expression of electrostatic energy for a uniformly charged non-conducting sphere of radius R. 2+5=7

19. (a) Deduce the relation $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$. Draw the field lines associated with $\vec{D}$, $\varepsilon_0 \vec{E}$ and $\vec{P}$. 3+2=5

(b) Deduce Gauss' law in dielectrics. 5

20. (a) State Biot-Savart law. Write it in vector form. 2+1=3

(b) Find the expression of magnetic field intensity at a point due to a long straight current carrying wire. Whether such magnetic field encircles the conductor? 6+1=7

21. (a) State and prove Ampere's circuital law. 3

(b) What is Helmholtz coil? Show that the rate of change of magnetic field at a point midway between two current-carrying co-axial coils is constant. 2+5=7

(Continued)

(a) Explain the variation of thermo-emf with temperature in detail. In this connection, define inversion temperature and neutral temperature. 3+2=5

(b) What is meant by thermoelectric power? Explain thermoelectric power diagram in detail. 1+4=5

(a) Describe how you can determine Peltier coefficient experimentally. 4

(b) Applying thermodynamic considerations to the working of a thermocouple, show that $\pi = T\frac{de}{dT}$, where symbols have their own meanings. 6

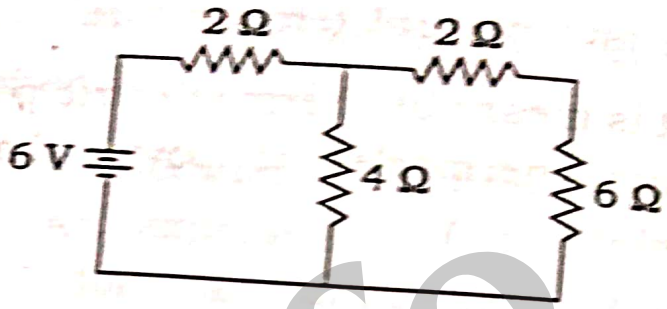
4. (a) Derive an expression for average power in series LCR circuit connected to a.c. supply. 4

(b) Derive an expression for resonant frequency of series resonant circuit. What will be the effect of resonant current if R is replaced by $2R$? 5+1=6

25. (a) State and prove Thevenin's theorem. 6

(Turn Over)

(b) Calculate the current flowing through the 6Ω resistance using Thevenin's theorem :



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