

2024

2nd Semester Examination

PHYSICS (Honours)

Paper : C 3-T

(Electricity and Magnetism)

[CBCS]

Full Marks : 40

Time : Two Hours

*The figures in the margin indicate full marks.
Candidates are required to give their answers
in their own words as far as practicable.*

Group - A

Answer any **five** of the following questions : $2 \times 5 = 10$

1. A sphere of radius a carries a charge density, $\rho(r) = kr$, where k is a constant. Show that total electric field outside the sphere is $E_0 = \frac{ka^4}{4\epsilon_0 r^2}$.
2. An electric field is represented by $\vec{E} = \hat{i}y + \hat{j}x$. Find the corresponding potential function ϕ . Assume $\phi = 0$ at $x = y = 0$.
3. Define electric susceptibility and dielectric constant. How are they related?

P.T.O.

(2)

4. A steady current of 2A flows through a coil of self-inductance 30 mH when connected to a 20 V dc supply. Calculate the current and power factor in a coil when it is reconnected to a 200 V, 50 Hz ac supply.
5. A long wire carrying a current of 100 amp is placed at right angle to a uniform external magnetic field of 50 T. Locate the point, at which the resultant magnetic field is zero.
6. Which property of $\vec{B}$ leads to the concept of magnetic vector potential ($\vec{A}$)? What is the unit of $\vec{A}$?
7. Magnetic susceptibility of Nickel is 600. If a Nickel sample is kept in a magnetising field of strength 100 A/m, then what will be the magnetic flux density inside the sample? Given : $\mu_0 = 4\pi \times 10^{-7} \text{ N/A}^2$.
8. What is reciprocity theorem?

Group - B

Answer any **four** of the following questions : 5×4=20

9. The electric field at any inside point of a charged sphere of radius a is $\vec{E} = Ar^3\hat{r}$. Find the volume charge density and total charge within the sphere. 3+2
10. State Thevenin and Norton Theorems. Are these theorems applicable in both ac and dc? Are they independent laws or can be derived from Kirchhoff's law?

(3)

11. Find the electric field produced by an infinite cylinder of radius ' a ' and volume charge density $\rho(r) = 5re^{-2r} \text{ C/m}^3$, r being the distance from the axis of the cylinder; at a point inside the cylinder.

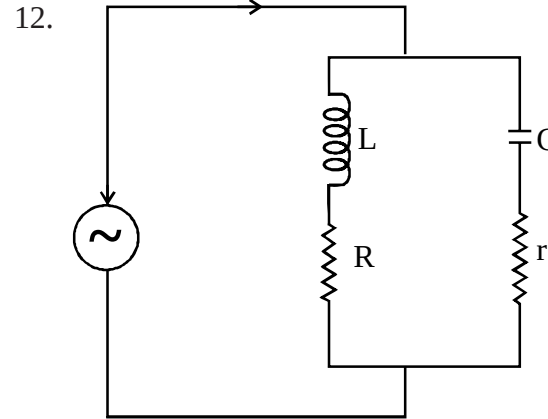


Fig.-1

For $V = V_0 \cos \omega t$, find the resonance frequency of the circuit in figure (1).

13. (a) Find an expression for force per unit length between two parallel current carrying conductors.
- (b) A current I flows through a wire shaped in the form of a square of side L . Determine the magnetic field at the centre of the square. 2+3
14. What do you understand by quality factor Q of a circuit? Explain the dependence of the sharpness of resonance on Q in a series LCR circuit.

P.T.O.

(4)

Group - C

Answer any **one** of the following questions : $10 \times 1 = 10$

15. (a) A square loop of wire of edge a carries a current i , show that value of B at the centre is given by,

$$B = \frac{2\sqrt{2}\mu_0 i}{\pi a}$$

- (b) An emf $E = 100\sin(377t + 30^\circ)$ volt is applied across a pure inductor of 0.02654 Henry. Calculate –

- (i) instantaneous current i
- (ii) instantaneous power P
- (iii) average power
- (iv) maximum energy stored in the inductance.

16. (a) Find the Thevenin and Norton equivalent circuits between the terminals a, b for the given network in figure (2).

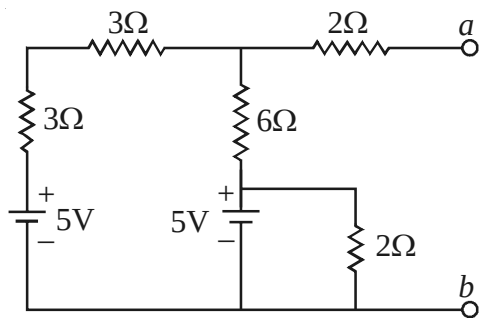


Fig.-2

(5)

- (b) A solenoid of length L and radius a stands on the XY plane with its axis coinciding with Z axis (see figure 3). Obtain the expression of magnetic field at a point $(0, 0, x)$.

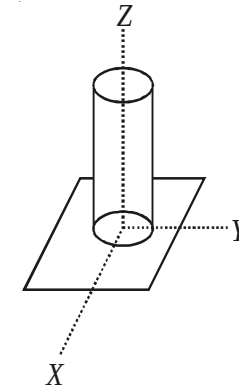


Fig.-3

5+5