[This question paper contains 8 printed pages.]

(5) Your Roll No. 2022

Sr. No. of Question Paper : 740 **B**

Unique Paper Code : 32221201

Name of the Paper : Electricity and Magnetism

Name of the Course : **B.Sc. (Hons) Physics-CBCS**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Question No. **1** is compulsory.
4. Answer any **four** of the remaining **six** questions.

1. Attempt **all** parts of this question :

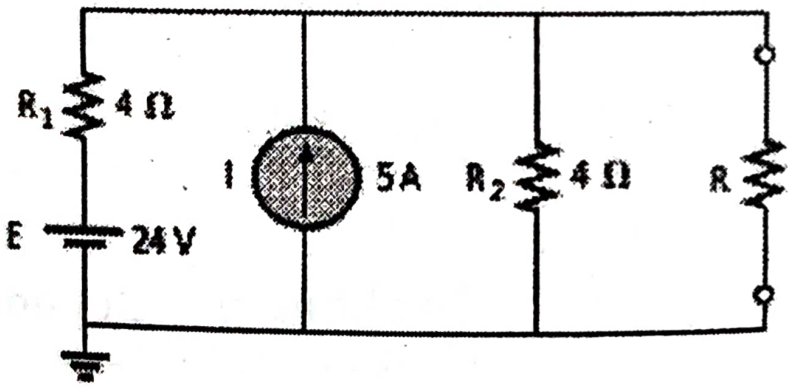
(a) The static charge distribution produces a radial electric field $\vec{E} = \frac{Ae^{-br}}{r^2}\hat{r}$ where A and b are constants. Calculate and plot the charge density distribution. What is the total charge Q? (3)

P.T.O.

(b) Determine if the vector field $\boldsymbol{A} = 2s(z+1)\sin\phi\ \hat{s} + s(z+1)\cos\phi\ \hat{\phi} + s^2\sin\phi\ \hat{z}$ corresponds to an electrostatic field or a magnetic field. (3)

(c) A square coil of side 60 cm rotates about the x – axis at $\omega = 60\,\pi$ rad/s in a field $B = 0.8\,\hat{k}$ Wb/m. Find the induced voltage. (3)

(d) For the given network, find the value of R for maximum power to R, and determine the maximum power to R.



(3)

(e) In a one-dimensional device the charge density is $\rho = \rho_o \frac{x}{x_o}$. If E = 0 at x = 0 and V = 0 at $x = x_o$, by solving the Poisson's equation find the electric potential V. (3)

(f) Show how the concept of displacement current explains the continuity of current by taking the example of a parallel-plate capacitor. (3)

(g) Define Hysteresis loss? (1)

2. (a) For a spherical charge distribution, the density is given by

$$\rho = \begin{cases} \rho_o(R^2 - r^2), & r \leq R \\ 0, & r > R \end{cases}$$

Determine the electric field E and the potential V for (a) r ≥ R (b) r ≤ R. (7)

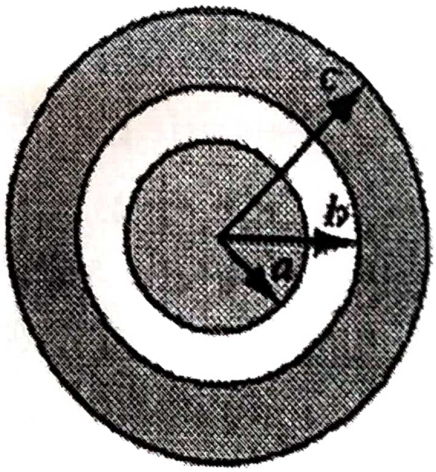
(b) An infinite uniform surface current K = 6î A/m flows over the x-y plane and a long straight wire carrying a steady current I is located along x-axis at z = 4 m. Determine I and its direction if B = 0 at (0,0,1.5) m. (7)

3. (a) A grounded metal sheet is placed in the z = 0 plane, while a point charge Q is located at (0, 0, a).

Find the force acting on a point charge – Q placed at (a, 0, a).

(7)

(b) A certain co-axial cable consists of a copper wire of radius a surrounded by a concentric copper tube of inner radius c. The space between them is partially filled (from b out to c) with a material of dielectric constant k. Find the capacitance per unit length of this cable?

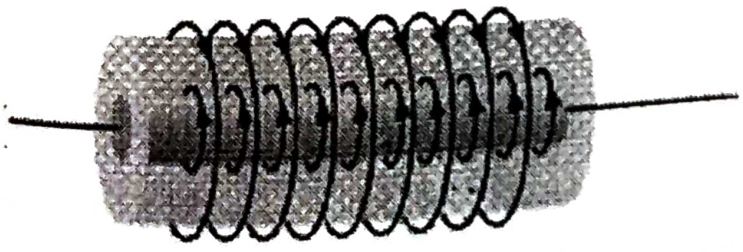


(7)

4. (a) A sphere of radius R, filled with material of dielectric constant k, have a small concentric spherical cavity of radius a. A free point charge q is placed at the center. Find the polarization vector P and bound charges σ_b and ρ_b. (7)

(b) Determine the quality factor and bandwidth for the response curve with peak current of 200 mA at its resonant frequency of 28 KHz. For capacitance C = 101.5 nF, determine the inductance L of the inductor, resistance R of the resistor and applied voltage for the series resonant circuit. (7)

5. (a) Two coaxial solenoids each carrying current I, but in opposite directions. The inner solenoid of radius a has N_1 turns per unit length and the outer of radius b has N_2 turns per unit length. Find B in each of the three regions: (i) inside the inner solenoid, (ii) between them and (iii) outside the outer solenoid.



(7)

(b) Consider a long and thin wire of radius a and made of a magnetic material with susceptibility χ_m. If the total current I is flowing in the wire such a way that the volume current density $\dot{J} = kr^3 \hat{z}$ (where k is a constant, r is the distance from the axis), find H, M, and B in the region inside and outside the wire. (7)

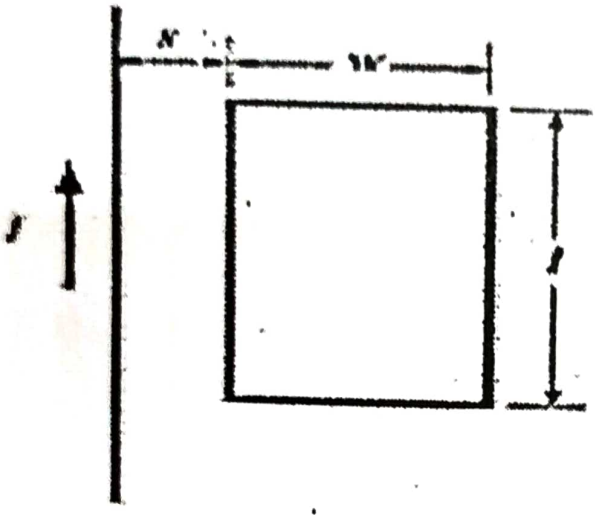
6. (a) Show that the potential of a magnetized object is given by

$$A = \frac{\mu_o}{4\pi}\int_V \frac{J_b}{r} d\tau + \frac{\mu_o}{4\pi}\oint_S \frac{K_b}{r} dS$$

where J_b and K_b are the bound volume current throughout the material and bound surface current respectively, r is the distance between the source point and the field point. (7)

(b) An infinite straight wire carries a current I is placed to the left of a rectangular loop of wire with width w and length I, as shown in the figure,

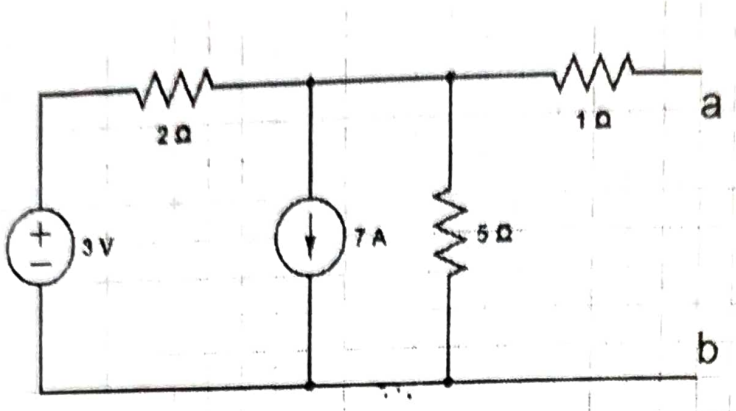
(i) Determine the magnetic flux through the rectangular loop due to current I. (ii) Compute the induced emf in the loop and the direction of the induced current for a time varying current I(t) = a + b t, where a and b are positive constants.



(7)

7. (a) A sphere of radius R carries a charge density $\rho(r) = k\left(1 - \frac{r}{R}\right)$, where k is a constant. Find the energy of the configuration. (7)

(b) Obtain the Thevenin equivalent circuit of the given circuit as shown in the figure. Draw the Norton equivalent of the Thevenin equivalent circuit.



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(6) Your Roll No. 2022

Sr. No. of Question Paper : 758 **B**

Unique Paper Code : 32221202

Name of the Paper : Wave and Optics

Name of the Course : **B.Sc. (Hons) Physics CBCS**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Answer any **five** questions in all.
3. Q. No. **1** is compulsory.

1. **Attempt any five questions. Each question carries 3 marks.** (3×5=15)

(a) **State and explain principle of superposition.**

(b) Two tuning forks A and B are used in an optical experiment to produce Lissajous figures. It is found that the sequence of figures repeats every 10 seconds. When fork A is loaded with a little wax, the sequence of the figures is found to repeat every 20 seconds. If the frequency of fork B is 400 Hz, determine the frequency of fork A.

(c) A parallel beam of light of wavelength 5890 A^0 is incident on a glass plate (μ=1.5) such that angle of refraction into plate is 60^0. Find the smallest thickness of the plate which will make it dark by reflection.

(d) What is the highest order of spectrum which may be seen with monochromatic light of wavelength 600 nm by means of diffraction grating with 5000 lines/cm?

(e) Explain Rayleigh's criterion of just resolution of two spectral lines of same intensities giving suitable intensity curve.

(f) Distinguish between Spatial and Temporal Coherence.

(g) How does Fraunhofer single slit diffraction pattern compare with Fresnel single slit diffraction pattern?

(h) In a biprism experiment, at a certain position of the eyepiece, the fringe width obtained is 0.2 mm. When the eyepiece is moved away by 50 cm, the fringe width becomes 0.3 mm. If the distance between two virtual sources is 0.3 cm, find the wavelength of the light used.

2. (a) What are beats? What are the necessary conditions to obtain them?

(b) Two vibrations along the same line are described by the equations

$x_1(t) = 0.05 \cos (8\pi t)$

$x_2(t) = 0.03 \cos (10\pi t)$

where x_1 and x_2 are in meters and t is in seconds. Derive the equation of the resultant vibration obtained by superimposing the given oscillations and hence find the beat period.

(c) Six simple harmonic oscillations each of same frequency and amplitude are superposed. The phase difference ϕ between any two consecutive oscillations is constant. If the resultant amplitude of the superposition is zero, what is the phase difference ϕ?

(3+7+5)

3. (a) What are stationary waves? Write it's any two characteristics.

(b) Derive the equation that describes a standing wave and its normal modes on a string of length L fixed rigidly at ends.

(c) The equation of a stationary wave is

$$y = 6\cos\frac{\pi x}{3}\sin 60\pi t$$

Find the (i) equations of the waves constituting the stationary waves (ii) wavelength and frequencies of these waves (iii) distance between successive nodes. (3+7+5)

4. (a) Why two independent sources of light of same wavelength cannot show interference? Explain briefly.

(b) Give the theory of formation of fringes in a wedge-shaped film and hence derive an expression for the path difference and fringe width

(c) Name the four characteristics of a coherent beam of light. Discuss Stoke's treatment for reflection and refraction. (3+7+5)

5. (a) Obtain Airy's formula for transmitted light in a Fabry Perot interferometer.

(b) Show that the fringes obtained with Fabry Perot interferometer are sharper than those obtained in Michelson's interferometer.

(c) In a Newton's rings experiment the diameter of the 10^{th} dark ring in the reflected system changes from 1.4 cm to 1.27 cm when a liquid is introduced between the lens and glass plate. Calculate the refractive index of the liquid. (7+5+3)

6. (a) Obtain an expression for intensity distribution in Fraunhofer double slit diffraction pattern and hence discuss the formation of maxima and minima.

(b) How does the intensity distribution in the above pattern differ from that in the Fraunhofer

diffraction pattern due to a single slit? Illustrate with diagrams.

(c) What is the phenomenon of Missing Orders in Fraunhofer double slit diffraction?

Find the order of missing spectra in a double slit diffraction pattern where the slit width is 0.16 mm and they are separated by 0.8 mm. the screen is placed 170 cm away from the slits. (7+5+3)

7. (a) What is a zone plate and how is it constructed?

(b) Give the theory of a zone plate and show that it has multiple foci.

(c) Compare the similarity and dissimilarity between a convex lens and a zone plate. Calculate the

radius of the first and second half period elements on a zone plate behaving like a convex lens of focal length 50 cm. Given $\lambda = 5000A°$.

(3+7+5)