School of Physics
University of Hyderabad
Minor examination – 1
Electromagnetic Theory – II

Date: 30/03/2022 Total Marks: 25 Time: 1 hour

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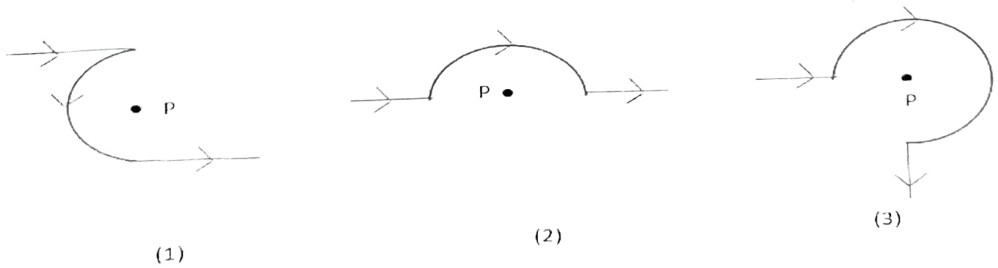
1. Two long parallel wires carrying equal currents in opposite directions are placed at x= -a and x=a to y axis with z=0. Match the following for the above (2 Marks)

Column 1	Column 2
A) Magnetic field B_1 at origin O	P) $\frac{\mu_0 i}{3\pi a}$
B) Magnetic field B_2 at P(2a,0,0)	Q) $\frac{\mu_0 i}{4\pi a}$
C) Magnetic field at M(a,0,0)	R) $\frac{\mu_0 i}{\pi a}$
D) Magnetic field at N(-a,0,0)	S) zero

(a) A→R, B→P, C→Q, D→ Q
(b) A→P, B→S, C→P, D→ Q
(c) A→P, B→P, C→R, D→ Q
(d) A→R, B→R, C→Q, D→ Q

2. Figure given below shows three cases: in all cases the circular part has radius r and straight ones are infinitely long. For the same current the field B at the centre P in the three cases (B_1:B_2:B_3) is (3 Marks)



(1) (2) (3)

(a) $-\frac{\pi}{2} : \frac{\pi}{2} : \frac{3\pi}{4} - \frac{1}{2}$ (b) $-\frac{\pi}{2} : \frac{\pi}{2} : \frac{3\pi}{4} + \frac{1}{2}$ (c) $-\frac{\pi}{4} : \frac{\pi}{2} : \frac{3\pi}{2} - \frac{1}{2}$ (d) $-\frac{\pi}{4} : \frac{\pi}{4} : \frac{3\pi}{2} - \frac{1}{4}$

3. A long solenoid of radius a is driven by an alternating current, so that the field inside is sinusoidal, $B(t) = B_0 \cos\omega t \hat{z}$. A circular loop of wire of radius $a/2$ and the resistance R is placed inside the solenoid, and co-axial with it. Find the current indeed in the loop as a function of time. (2 Marks)

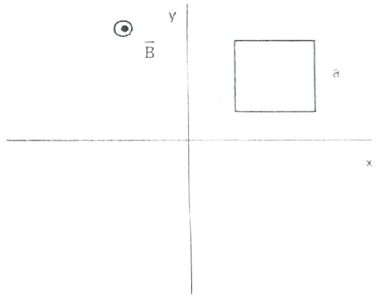
4. A square loop of wire with sides of length a, lies in the first quadrant of the xy plane, with one corner at the origin, there is a non-uniform time dependent magnetic field $B(y,t) = ky^4t^4\hat{z}$ (where k is constant). Find the emf induced in the loop. (2 Marks)

5. A charge of 12C has velocity of $5\overrightarrow{a_x} + 2\overrightarrow{a_y} - 3\overrightarrow{a_z}$ m/s. Determine force (F) on the charge in the field of (2 Marks)
   (a) $\vec{E} = 18\overrightarrow{a_x} + 5\overrightarrow{a_y} - 10\overrightarrow{a_z}$ V/m

   (b) $\vec{B} = 4\overrightarrow{a_x} + 4\overrightarrow{a_y} - 3\overrightarrow{a_z}$ Tesla

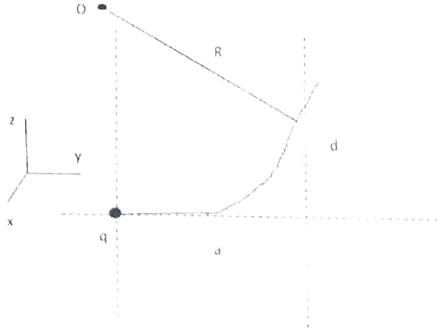
6. For static and uniform fields show that $\phi = -\mathbf{E}.\mathbf{r}$, $\mathbf{A} = \frac{1}{2}(\mathbf{B} \times \mathbf{r})$ (2 Marks)

7. A square loop of wire lies on the table, at a distance S from a very long straight wire, which carries a current I



   (a) find the flux of B through loop
   (b) if we now pull the loop directly away from the wire, at speed v, what is the emf generated? In what direction does the current flow?
   (c) what will happen if loop is pulled to the right at speed v (2 Marks)

8. A particle of charge q enters a region of uniform magnetic field B (pointing into the page). The field deflects the particle a distance d above the original line of flight, as shown in figure. Is the charge positive or negative? find the momentum of the particle in terms of a,b,B and q. (3 Marks)



9. Explain the multipole expansion of the vector potential (4 Marks)
10. Assume that the Earth magnetic field is caused by a small current loop located at the centre of the Earth. Given that the field near the pole is 0.8 gauss, that the radius of the Earth is $R = 6x10^6$ m, and that $\mu_0 = 4\pi \times 10^{-7}$ H/m, use the Biot Savart law to calculate the strength of the magnetic moment of the small current loop? (3 Marks)