

Department of Electrical engineering
College of Engineering
EE 351 Electromagnetic Fields
Problem Set 6 (Magnetic Field)

Biot and Savart law (Section 7.2)

Problem 1

PRACTICE EXERCISE 7.2

The positive y -axis (semi-infinite line with respect to the origin) carries a filamentary current of 2 A in the $-\mathbf{a}_y$ direction. Assume it is part of a large circuit. Find \mathbf{H} at

(a) $A(2, 3, 0)$

(b) $B(3, 12, -4)$

Answer: (a) $145.8\mathbf{a}_z$ mA/m, (b) $48.97\mathbf{a}_x + 36.73\mathbf{a}_z$ mA/m.

Problem 2

7.3 Two infinitely long wires, placed parallel to the z -axis, carry currents 10 A in opposite directions as shown in Figure 7.28. Find \mathbf{H} at point P .

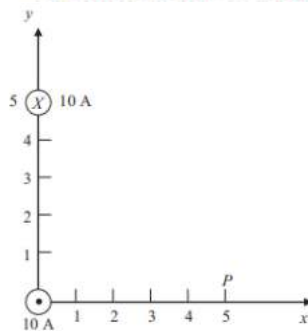


FIGURE 7.28 For Problem 7.3.

Problem 3

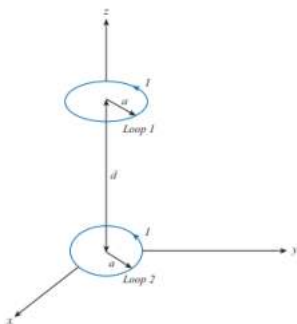
EXAMPLE 7.3

A circular loop located on $x^2 + y^2 = 9, z = 0$ carries a direct current of 10 A along \mathbf{a}_ϕ . Determine \mathbf{H} at $(0, 0, 4)$ and $(0, 0, -4)$.

Problem 4

7.16 Two identical loops are parallel and separated by distance d as shown in Figure 7.35.

Calculate \mathbf{H} at $(0, 0, d)$ assuming that $a = 3$ cm, $d = 4$ cm, and $I = 10$ A.



Problem 5

PRACTICE EXERCISE 7.3

A thin ring of radius 5 cm is placed on plane $z = 1$ cm so that its center is at $(0, 0, 1 \text{ cm})$. If the ring carries 50 mA along \mathbf{a}_ϕ , find \mathbf{H} at

- (a) $(0, 0, -1 \text{ cm})$
- (b) $(0, 0, 10 \text{ cm})$

Answer: (a) $400\mathbf{a}_z$ mA/m, (b) $57.3\mathbf{a}_z$ mA/m.

Problem 6

PRACTICE EXERCISE 7.4

The solenoid of Figure 7.9 has 2000 turns, a length of 75 cm, and a radius of 5 cm. If it carries a current of 50 mA along \mathbf{a}_z , find \mathbf{H} at

- (a) $(0, 0, 0)$
- (b) $(0, 0, 75 \text{ cm})$
- (c) $(0, 0, 50 \text{ cm})$

Answer: (a) $66.52\mathbf{a}_z$ A/m, (b) $66.52\mathbf{a}_z$ A/m, (c) $131.7\mathbf{a}_z$ A/m.

Ampere's law (Section 7.3)

Problem 7

EXAMPLE 7.5

Planes $z = 0$ and $z = 4$ carry current $\mathbf{K} = -10\mathbf{a}_x$ A/m and $\mathbf{K} = 10\mathbf{a}_x$ A/m, respectively. Determine \mathbf{H} at

- (a) $(1, 1, 1)$
- (b) $(0, -3, 10)$

Problem 8

PRACTICE EXERCISE 7.5

Plane $y = 1$ carries current $\mathbf{K} = 50\mathbf{a}_z$ mA/m. Find \mathbf{H} at

- (a) $(0, 0, 0)$
- (b) $(1, 5, -3)$

Problem 9

7.21 The $z = 0$ plane carries current $\mathbf{K} = 10\mathbf{a}_x$ A/m, while current filament situated at $y = 0, z = 6$ carries current I along \mathbf{a}_x . Find I such that $\mathbf{H}(0, 0, 3) = \mathbf{0}$.

Problem 10

PRACTICE EXERCISE 7.6

A toroid of circular cross section whose center is at the origin and axis the same as the z -axis has 1000 turns with $\rho_o = 10$ cm, $a = 1$ cm. If the toroid carries a 100 mA current, find $|\mathbf{H}|$ at

- (a) $(3 \text{ cm}, -4 \text{ cm}, 0)$
- (b) $(6 \text{ cm}, 9 \text{ cm}, 0)$

Problem 11

7.23 An infinitely long cylindrical conductor of radius a is placed along the z -axis. If the current density is $\mathbf{J} = \frac{J_o}{a}\mathbf{a}_z$, where J_o is constant, find \mathbf{H} everywhere.