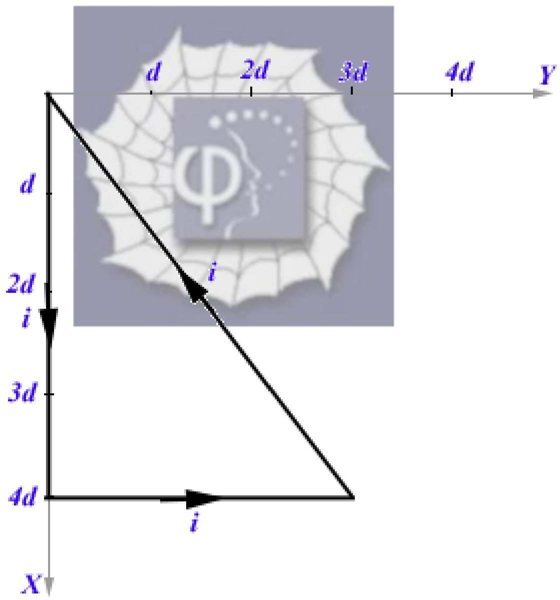
473.

Problem 35.41 (RHK)

In a certain region there is a uniform current density of $15\ \mathrm{A\ m^{-2}}$ *in the positive z direction. We have to find the value of* $\oint \vec{B}.d\vec{s}$ *when the line integral is taken along three straight-line segments from* $(4d,0,0)$ *to* $(4d,3d,0)$ *to* $(0,0,0)$ *to* $(4d,0,0)$, *where* $d = 23\ \mathrm{cm}$.



Solution:

As the line integral is traversed in the counter-clockwise direction, and as the currents enclosed are in the z direction, they will contribute with positive sign in the Ampere's law. It is given that the current density is uniform and is 15 A m^{-2}. From the diagram, we note that as the area enclosed by the Amperian path is that of a triangle with base *3d* and height *4d*, it is

$$A = \frac{1}{2} \times 4d \times 3d = 6d^2.$$

$$\therefore \oint \vec{B}.d\vec{s} = \mu_0 \times 6d^2 \times j,$$

where the current density

$$j = 15 \text{ A m}^{-2}.$$

$$\therefore \oint \vec{B}.d\vec{s} = \mu_0 \times 6 \times (0.23)^2 \times 15 \text{ T m}$$

$$= 4\pi \times 10^{-7} \times 6 \times (0.23)^2 \times 15 \text{ T m}$$

$$= 5.98\ \mu\text{T m}.$$