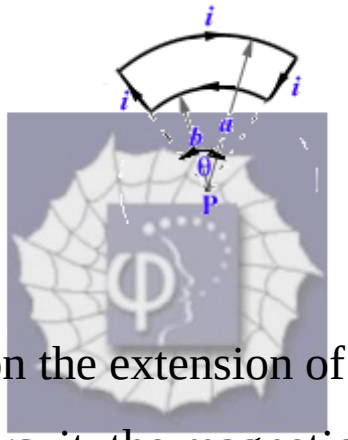
461.

Problem 35.15 (RHK)

Consider the circuit shown in the figure. The curved segments are arcs of circles of radii a and b. We have to find the magnetic field $\vec{B}$ *at* P, *assuming a current i in the circuit.*



Solution:

As the point P is on the extension of the straight-line segments of the circuit, the magnetic field at P due to these segments will be zero. The magnetic field at P due to the arc of circle of radius *a* will be in the direction of $-\hat{k}$, if the circuit is in the $\hat{i}$ - $\hat{j}$ plane, and $\hat{i} \times \hat{j} = \hat{k}$.

As the direction of the current flow in the arc of the circle of radius *b* is in the counter-clockwise direction, the magnetic field at P due to this segment of the circuit will be in the direction $\hat{k}$. We, therefore, find the magnetic field at P to be given by

$$\overset{\mathrm{r}}{B}(P)=\frac{\mu_0 i}{4\pi}\left(\frac{a\theta}{a^2}\left(-\hat{k}\right)+\frac{b\theta}{b^2}\hat{k}\right)=\frac{\mu_0 i}{4\pi}\theta\frac{(a-b)}{ab}\hat{k}.$$

The magnitude of the magnetic field at P will be

$$B(P)=\frac{\mu_0 i}{4\pi}\theta\frac{(a-b)}{ab}.$$