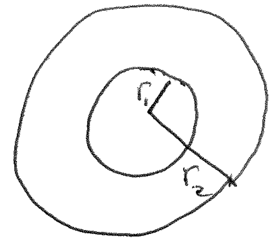
Ch 12 : Prob. 46

$I = 50A$

(evenly distributed over the cross-section)



$r_1 = 3.0 cm$

$r_2 = 5.0 cm$

By Ampere's Laws $\oint B \cdot ds = \mu_0 I_{enc}$

at r = 2.0 cm

By circular symmetry

$$B \cdot 2\pi r = \mu_0 I_{enc} \rightarrow B = \frac{\mu_0 I_{enc}}{2\pi r}$$

~~Since~~

Since $r < r_1$, There is no current enclosed

$$\therefore \boxed{B = 0 T}$$

at r = 4.0 cm

Since the current is uniformly distributed over the area, the current enclosed at r = 4.0 cm will be proportional to the area of the area enclosed to the total area.

$$\text{Total Area} = A_{outer\,circle} - A_{inner\,circle} = \pi r_2^2 - \pi r_1^2 = \pi(r_2^2 - r_1^2)$$

$$A_{tot} = \pi\left((5.0cm)^2 - (3.0cm)^2\right) = \pi(25-9)cm^2 = \underline{\underline{16\pi\ cm^2}}$$

$$\text{enclosed Area} = \pi r^2 - \pi r_1^2 = \pi(r^2 - r_1^2)$$

$$A_{enc} = \pi\left((4.0cm)^2 - (3.0cm)^2\right) = \pi(16-9)cm^2 = \underline{\underline{7\pi\ cm^2}}$$

$$I_{enc} = \frac{A_{enc}}{A_{tot}} \cdot I_{tot} = \frac{7\pi\ cm^2}{16\pi\ cm^2} \cdot (50A) = \frac{7}{16}(50)A = \underline{\underline{21.9A}}$$

$$B = \frac{\mu_0 I_{enc}}{2\pi r} = \frac{\left(4\pi \times 10^{-7} \frac{Tm}{A}\right)(21.9\ A)}{2\pi\ (4.0 \times 10^{-2} m)} = \boxed{1.10 \times 10^{-4}\ T}$$

at r = 6.0 cm

At this distance all of the current is enclosed.

$$\therefore B = \frac{\mu_0 I_{enc}}{2\pi r} = \frac{\left(4\pi \times 10^{-7} \frac{Tm}{A}\right)(50A)}{2\pi\ (6.0 \times 10^{-2} m)} = \boxed{1.67 \times 10^{-4}\ T}$$