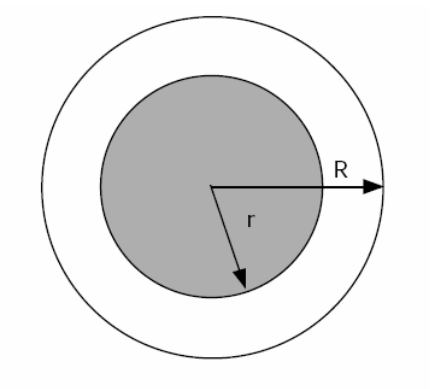
Homework Solution "Ampere's Law"

Problem: A long straight wire has a circular cross section of radius R. If the current is uniformly distributed over the volume of the wire, what is the magnetic field at a distance r<R (inside the wire).

Solution:



$$\int B dl = \mu_o I_{enclosed}$$

Where the radius is r, B is constant

$$B\int dl = \mu_o I_{enclosed}$$

Do the integaration…

$$B\int_0^{2\pi r} dl = B2\pi r = \mu_o I_{enclosed}$$

Now the current in uniform over the entire area of the wire, so the enclosed current is simply the total current times the ratio of the enclosed area to the total area…

$$I_{enclosed} = I_o \frac{\pi r^2}{\pi R^2}$$

So this gives us… $\boxed{B = \mu_o I \frac{r}{2\pi R^2}}$