Physics 161.002
Homework XI (Due 4/7/05)

Ch 30/P 35

\[ O \rightarrow J = \frac{J_0}{a} \]

Ampere's Law: \[ \oint B \cdot dl = \mu_0 I_{\text{enc.}} \]

\[ i = \int J \, d\alpha \]

Loop - Circle of radius \( r \)

\[ \Phi = 2\pi r^2 \frac{d}{2} = \mu_0 \int J(\alpha) \cdot 2\pi r^2 \, d\alpha \]

\[ B = \frac{\mu_0 J_0}{a} \int_0^a 2\pi r^2 \, d\alpha = \frac{\mu_0 J_0}{a} \left[ \frac{r^3}{3} \right]_0^a \]

\[ B \cdot 2\pi r^2 = 2\pi \frac{\mu_0 J_0}{a} \frac{r^3}{3} \]

\[ B = \frac{\mu_0 J_0 r^2}{3a} \]

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Solenoid: \( N = 1200 \) turns \( \quad r = 0.02 \text{m} \)

\( L = 0.95 \text{m} \quad i = 3.6 \text{A} \)

\[ B_{\text{Solenoid}} = \frac{\mu_0 \mu_i N}{L} = \frac{\mu_0 \mu_i N}{L} \left[ \frac{(4\pi \times 10^{-7} \text{ T} \cdot \text{m} / \text{A}) (3.6 \text{A})}{0.95 \text{m}} \right] \]

\[ B_{\text{Solenoid}} = 5.7 \times 10^{-2} \text{T} \]

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Toroid

\[ N = 500 \text{ turns} \]

\[ i = 0.8 \text{A} \]

\[ \frac{\mu_0 \mu_i N}{2\pi r} \]

a) \[ B_{\text{Toroid}} = \frac{\mu_0 \mu_i N}{2\pi r} \left[ \frac{4\pi \times 10^{-7} \text{ T} \cdot \text{m} / \text{A}}{0.8 \text{A}} \right] (500) \]

\[ B_{\text{Toroid}}(0.15 \text{m}) = 5.38 \times 10^{-2} \text{T} \]

b) \[ B_{\text{Toroid}} = B_{\text{Toroid}}(0.15 \text{m}) \cdot \frac{r_{\text{outer}}}{r_{\text{inner}}} = (5.38 \times 10^{-2} \text{T}) \frac{0.25}{0.15} \]

\[ = 4 \times 10^{-2} \text{T} \]