OEM

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4. **6.8** The transformer shown in Fig. P6.8 consists of a long wire coincident with the z-axis carrying a current $I = I_0 \cos \omega t$, coupling magnetic energy to a toroidal coil situated in the x–y plane and centered at the origin. The toroidal core uses iron material with relative permeability μ_r, around which 100 turns of a tightly wound coil serves to induce a voltage V_{emf}, as shown in the figure.

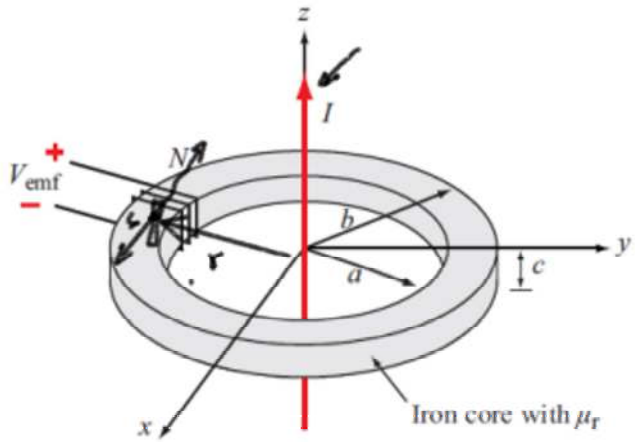

Figure P6.8 Problem 6.8.

$$\left[B = \frac{\mu I}{2\pi r}\right]$$

$$ds = c\,dr$$

$$\phi_B = \int_A B\,dS = -N\mu_0\mu_r \frac{I_0}{2\pi} c \int_{r=a}^{r=b} \frac{dr}{r}$$

$$e = -N\frac{d\phi}{dt} = \omega\mu_0\mu_r I_0 N \ln$$

E_0

(a) Develop an expression for V_{emf}.

(b) Calculate V_{emf} for $f = 60$ Hz, $\mu_r = 4000$, $a = 5$ cm, $b = 6$ cm, $c = 2$ cm, and $I_0 = 50$ A.

$$I_0 \cos \omega t$$

$$\mu_0 \mu_r \frac{I}{2\pi} c \ln\left(\frac{b}{a}\right)$$

$$\ln(b/a)\, \operatorname{sen} \omega t = E_0 \operatorname{sen} \omega t$$