H18

問2

(1)

$$\int H\,dl = NI$$

$$H = \frac{NI}{l}$$

(2)

$$\Phi = \mu H S$$

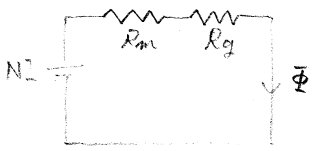
$$= \frac{\mu N S I}{l}$$

$$N\Phi = LI$$

$$L = \frac{\mu N^2 S}{l}$$

(3)

等価回路は



$$R_m = \frac{l-\delta}{\mu S}, \quad R_g = \frac{\delta}{\mu_0 S}$$

$$NI = (R_m + R_g)\Phi$$

$$\Phi = \frac{NI}{R_m + R_g}$$

$$= \frac{\mu\mu_0 NI S}{\mu_0(l-\delta) + \mu\delta}$$

$$\Phi = BS = \mu_0 H S$$

$$H_g = \frac{\mu NI}{\mu_0(l-\delta) + \mu\delta}$$

磁生体内部に生じる磁界は

$$H_m = \frac{1}{\mu S}\Phi$$

$$\frac{H_g}{H_m} = \frac{\mu}{\mu_0}$$

(4)

磁生体内部の磁気エネルギーは単位体積あたり

$$W_m = \frac{1}{2} B H_m = \frac{1}{2}\mu H_m^2$$

$$= \frac{1}{2}\mu\left(\frac{\Phi}{\mu S}\right)^2$$

$$= \frac{\mu}{2\mu^2 S^2}\left(\frac{\mu\mu_0 NIS}{\mu_0(l-\delta)+\mu\delta}\right)^2$$

$$= \frac{\mu\mu_0^2 N^2 I^2}{2\{\mu_0(l-\delta)+\mu\delta\}^2}$$

$$W_g = \frac{1}{2}\mu_0 H_g^2$$

$$= \frac{1}{2}\mu_0 \frac{\mu^2 N^2 I^2}{\{\mu_0(l-\delta)+\mu\delta\}^2}$$

$$= \frac{\mu_0\mu^2 N^2 I^2}{2\{\mu_0(l-\delta)+\mu\delta\}^2}$$

体積をかけて

$$W_m' = W_m \cdot S\cdot(l-\delta)$$

$$= \frac{S\cdot(l-\delta)\mu\mu_0^2 N^2 I^2}{2\{\mu_0(l-\delta)+\mu\delta\}^2}$$

$$W_g' = W_g \cdot S\cdot\delta$$

$$= \frac{S\cdot\delta\,\mu\mu_0^2 N^2 I^2}{2\{\mu_0(l-\delta)+\mu\delta\}^2}$$

$$\frac{W_m'}{W_g'} = \frac{\mu}{\mu_0}\cdot\frac{\delta}{l-\delta}$$