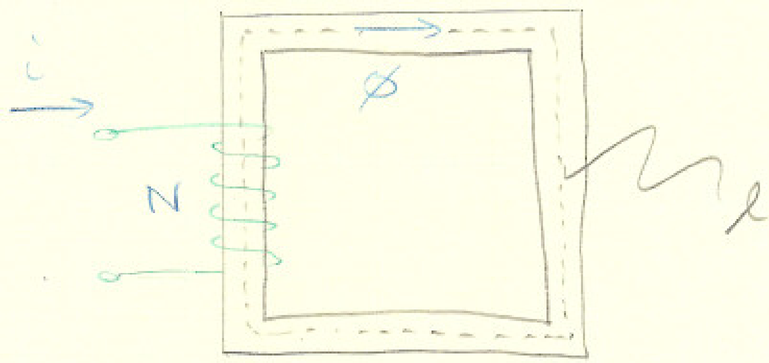
Magnetic Circuits



A : cross sectional area

l : mean length

Assumptions : No leakage flux
Uniform flux density.

ϕ : flux

$$\boxed{\begin{array}{c}\text{Ampere's Law}\\ \mathcal{F} = \oint \vec{H} \cdot d\vec{l}\end{array}}$$

$\mathcal{F} = Ni$ } much simplier

Note: Polarity of magneto motive force ($\mathcal{F}$) can be determined by right hand rule

H: magnetic feild intensity. (A/m)
B: flux density (wb)
ϕ: flux (wb/m²)

Some other relationships

$$\vec{B} = \mu \vec{H}$$

magnetic permibility.
feild intensity

$$\phi = \int_S \vec{B} \cdot d\vec{A} = BA$$

$$\mu = \mu_o \mu_r$$

constants ($4\pi \times 10^{-7}$ H/m)
relative permibility.

Back to the magnetic circuit....

$$\mathcal{F} = Ni$$

$$\mathcal{F} = \oint H \, dl$$

$$= \oint \frac{B}{\mu} \, dl$$

$$= \frac{B}{\mu} \oint dl$$

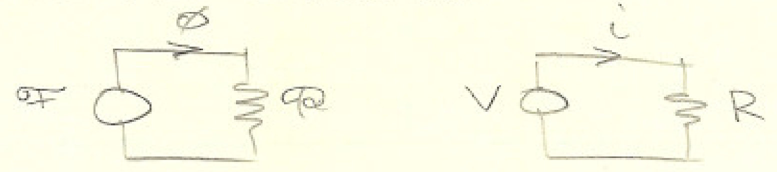
$$= \frac{Bl}{\mu}$$

$$= \frac{l}{A\mu} \phi$$

$$= \mathcal{R} \phi$$

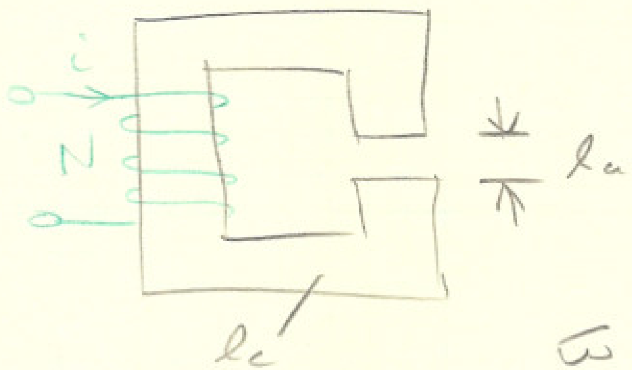
$\mathcal{R}$: reluctance. $\left(\frac{A \cdot t}{wb}\right)$

Magnetic circuits behave in the same manner as electric circuits



All relations of series and parrell still apply.

EX



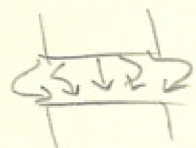
$N = 500$
$\mu_r = 70{,}000$
$B_c = 1\ wb/m^2$
$d = 3cm$ (depth)
$l_a = 0.05\ cm$
$l_c = 30\ cm$

w square cross sectional area

Find $\mathcal{R}_a$, $\mathcal{R}_c$, ϕ, & i

$A = 0.009\ m^2$

Note: Fringing: in reality the flux is not constant through the air



Ignoried in most of our cases.

$$\mathcal{R}_c = \frac{l_c}{\mu A} = \frac{l_c}{\mu_o \mu_r d^2} = 3789.4\ \frac{A \cdot t}{wb.}$$

$$\mathcal{R}_a = \frac{l_a}{\mu A} = \frac{l_a}{\mu_o d^2} = 442100\ \frac{A \cdot t}{wb.}$$

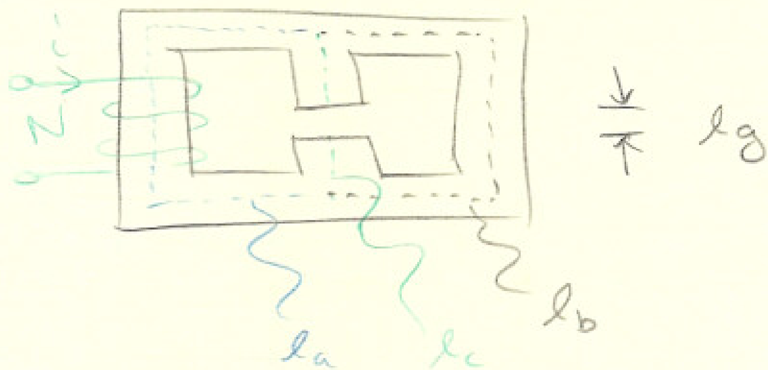
$$\phi = B_c A = 0.0009\ wb.$$

$$\mathcal{R}_T = \mathcal{R}_c + \mathcal{R}_a = 445890\ \frac{A \cdot t}{wb}$$

$$\mathcal{F} = \phi \mathcal{R}_T = Ni$$

$$i = \frac{\phi \mathcal{R}_T}{N} = 0.8026\ A$$

EX

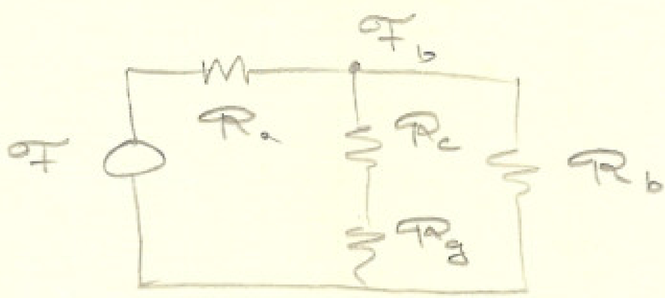


A: cross section area

Find ϕ_A, ϕ_b, ϕ_c

$$\mathcal{R}_a = \frac{l_a}{\mu_r \mu_o A} \qquad \mathcal{R}_c = \frac{l_c}{\mu_r \mu_o A}$$

$$\mathcal{R}_b = \frac{l_b}{\mu_r \mu_o A} \qquad \mathcal{R}_g = \frac{l_g}{\mu_o A}$$



$$\mathcal{R}_T = \mathcal{R}_a + (\mathcal{R}_c + \mathcal{R}_g) \parallel \mathcal{R}_b$$

$$\phi_A = \frac{\mathcal{F}}{\mathcal{R}_T} \qquad \mathcal{F}_b = \mathcal{F} - \phi_A \mathcal{R}_a$$

$$= \phi_a \left[(\mathcal{R}_c + \mathcal{R}_g) \parallel \mathcal{R}_b \right]$$

$$\phi_b = \frac{\mathcal{F}_b}{\mathcal{R}}$$

$$\phi_c = \frac{\mathcal{F}_b}{\mathcal{R}_c + \mathcal{R}_g}$$