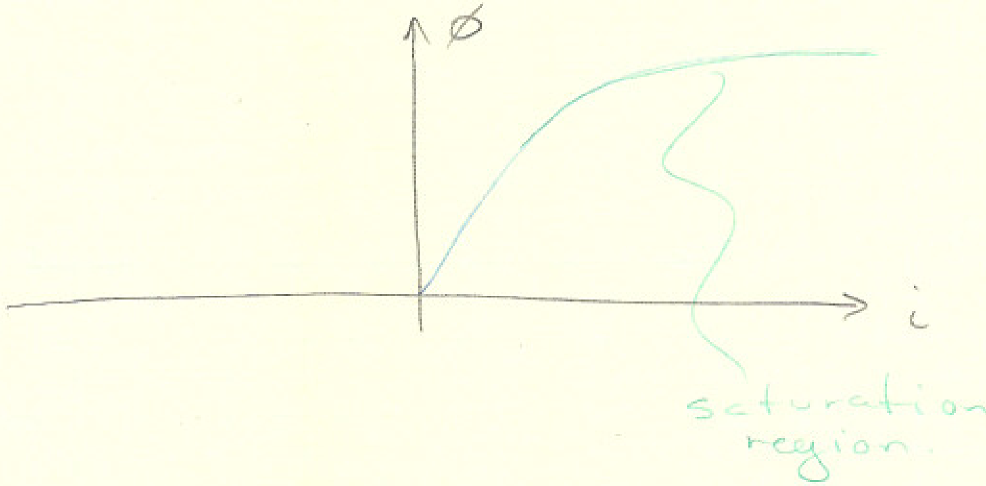
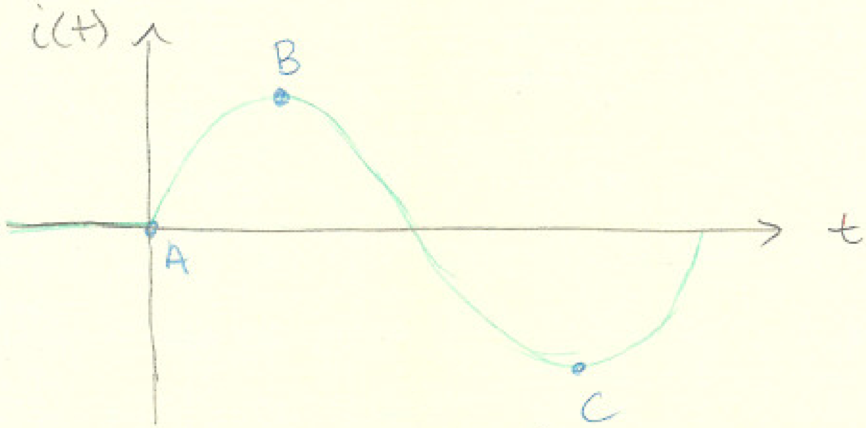
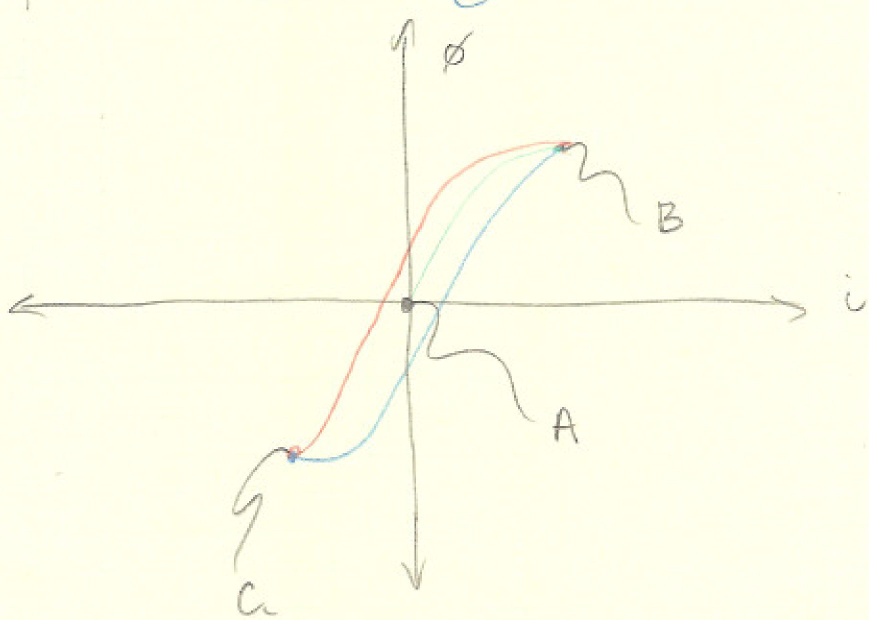
Magnetization Curve



Hysteresis Law





? $P_h = k_h f B_{max}^n V$?

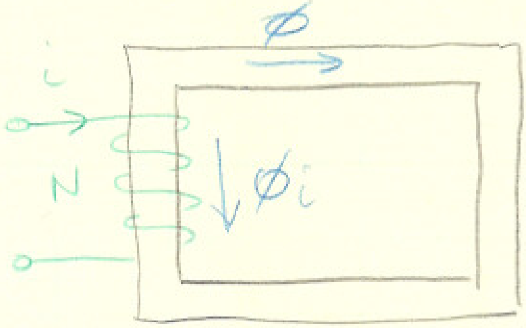
Excitation current and Faraday's Law.

*Faraday's Law:

A time varying flux produces an induced voltage in the coil; which is determined by:

$$e = \frac{d\lambda}{dt} = \frac{d(N\phi)}{dt} = N\frac{d\phi}{dt}.$$

The polarity of the induced voltage is such that if the winding ends were short-circuited it would produce current that would cause a flux opposing the original flux change.



If there is flux in the magnetic circuit; then a current forms in the coil; which in turn creates opposing flux. (ϕi)

$$\phi(t) = \phi_{max}\sin(\omega t)$$

$$e = N\frac{d\phi}{dt}$$

$$e = N\omega\phi_{max}\cos(\omega t)$$

$$e = E_{max}\cos(\omega t)$$

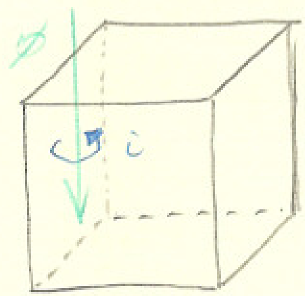
$$e = \frac{\sqrt{2}}{\sqrt{2}}E_{max}\cos(\omega t)$$

$$E_{rms} = \frac{E_{max}}{\sqrt{2}} = \frac{N\omega\phi_{max}}{\sqrt{2}} = \frac{2\pi f N\phi_{max}}{\sqrt{2}}$$

$$= \sqrt{2}\,\pi f N A B_{max}$$

Excitation Current / flux

Eddy Current



eddy current loss:

$$P = i_\phi^2 R$$

To reduce eddy current loss we use thin sheets of lamination material.

thickness of material.

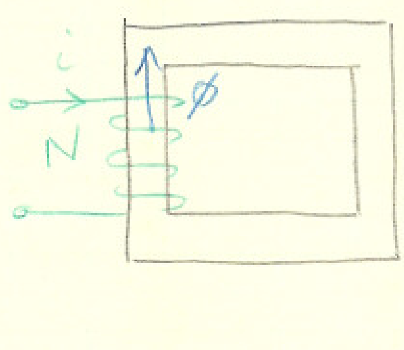
$$P_e = k f^2 \delta^2 B_{max}^2 V$$

freq(Hz)

total Volume of material

$$P_{core} = P_e + P_h$$

Inductances



$$\lambda = N\phi$$

$$e = \frac{d\lambda}{dt} = N\frac{d\phi}{dt}$$

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

$$e = N\frac{d\left(\frac{Ni}{\mathcal{R}}\right)}{dt}$$

$$e = \frac{N^2}{\mathcal{R}}\cdot\frac{di}{dt}$$

compare with... $v = L\frac{di}{dt}$

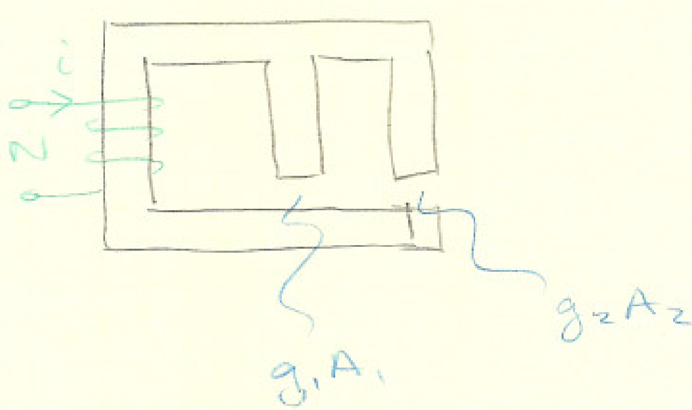
$$\therefore \quad L = \frac{N^2}{\mathcal{R}}$$

$$L \equiv \frac{\lambda}{i}$$

again

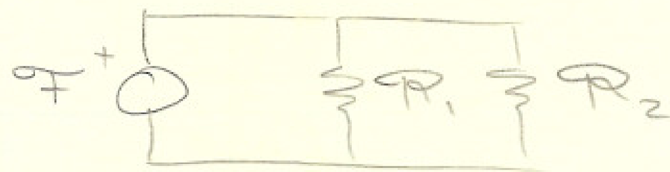
$$L = \frac{N\phi}{i} = \frac{N\frac{Ni}{\mathcal{R}}}{i} = \frac{N^2}{\mathcal{R}}$$

Ex:



Find: L & B

SOL



$$\mathcal{R}_T = \frac{\mathcal{R}_1 \mathcal{R}_2}{\mathcal{R}_1 + \mathcal{R}_2}$$

$$\mathcal{R}_1 = \frac{g_1}{\mu_0 A_1} \qquad \mathcal{R}_2 = \frac{g_2}{\mu_0 A_2}$$

$$\therefore \quad \mathcal{R}_T = \frac{1}{\mu_0\left(\frac{A_2}{g_2} + \frac{A_1}{g_1}\right)}$$

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

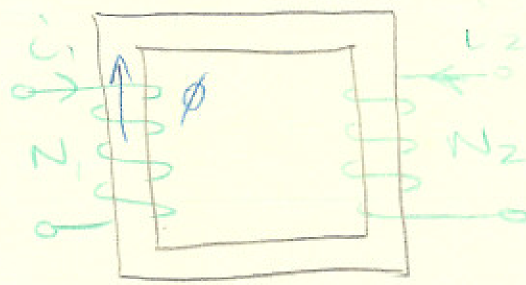
$$\phi = \mu_0 N i \left(\frac{A_1}{g_1} + \frac{A_2}{g_2}\right)$$

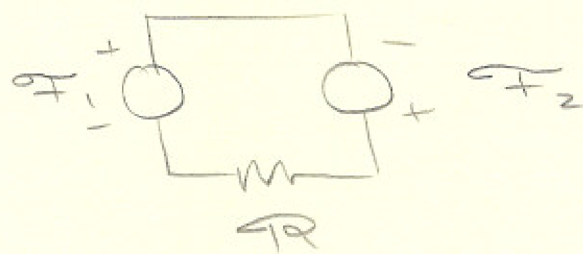
$$L = \frac{N\phi}{i} = \mu_0 N^2 \left(\frac{A_1}{g_1} + \frac{A_2}{g_2}\right)$$

$$\phi_1 = \frac{\mathcal{F}}{\mathcal{R}_1} = \frac{N i \mu_0 A_1}{g_1}$$

$$B_1 = \frac{\phi_1}{A_1} = \frac{\mu_0 N i}{g_1}$$

Mutual Inductance





$$\phi = \frac{\mathcal{F}}{\mathcal{R}} = \frac{\mathcal{F}_1 + \mathcal{F}_2}{\mathcal{R}} = \frac{N_1 i_1 + N_2 i_2}{\mathcal{R}}$$

$$= \frac{N_1 i_1 + N_2 i_2}{\frac{l}{\mu A}} = \boxed{\frac{\mu A N_1}{l} i_1 + \frac{\mu A N_2}{l} i_2}$$

$$\lambda_1 = N_1 \phi = \frac{\mu A N_1^2}{l} i_1 + \frac{\mu A N_1 N_2}{l} i_2$$

$$\lambda_1 = \lambda_{11} + \lambda_{12}$$

$$L_{11} = \frac{\lambda_{11}}{i_1} = \frac{\mu A N_1^2}{l}$$

$$L_{12} = \frac{\lambda_{12}}{i_2} = \frac{\mu A N_1 N_2}{l}$$

$$\lambda_2 = N_2 \phi = \frac{\mu A N_1 N_2}{l} i_1 + \frac{\mu A N_2^2}{l} i_2$$

$$\lambda_2 = \lambda_{21} + \lambda_{22}$$

$$L_{21} = \frac{\lambda_{21}}{i_1} = \frac{\mu A N_1 N_2}{l}$$

$$L_{22} = \frac{\lambda_{22}}{i_2} = \frac{\mu A N_2^2}{l}$$