Lecture 9

Friday, 9 February 2024 3:35 PM

EE114 - Power Engineering 1

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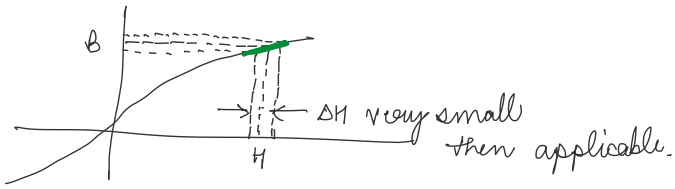
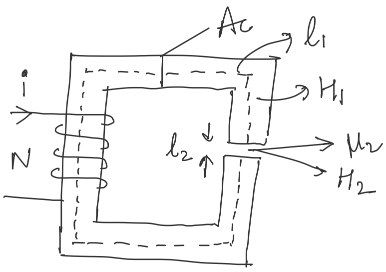
Ques :- We can use electrical equivalent circuit when we consider μ to be constant. Can it be used in real life?

Ans. Yes. If μ is not changing much around its operating point. Suppose operating point is somewhere in saturation. But the region of operation on B-H curve is such that μ is constant. Then also we can use it





$i \leftrightarrow H \leftrightarrow B \;\; \phi \leftrightarrow e$

$$\phi_1 = \phi_2$$

$$A_{c_1} B_1 = A_{c_2} B_2$$

$$A_{c_1} \mu_1 H_1 = A_{c_2} \mu_2 H_2$$

$$\oint H.dl = Ni$$

$$\boxed{H_1 l_1 + H_2 l_2 = Ni}$$

$$H_1 = \frac{\mu_2 A_{c_2} N i}{\mu_2 l_1 A_{c_2} + l_2 A_{c_2} \mu_1}$$

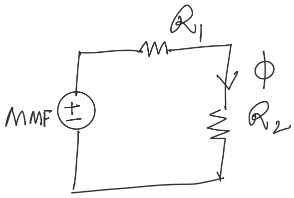
$$R = \frac{l}{\mu A}$$

Because of saturation happening at core & air boundary there may be some fringing flux. To account for it air gap cross sectional area $A_{eff} = 5\text{ to }7\%\ A_c$.

It can be approximated that $A_{c_1} = A_{c_2}$

$$H_1 = \frac{\mu_2 N_i}{\mu_2 l_1 + \mu_1 l_2}$$

$$\phi_1 = A_{c_1} \mu_1 H_1$$

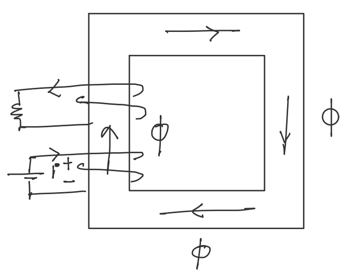


Intentional introduction of air gap??

If we are applying a certain voltage across winding the flux may be such that the operating region will be in saturation region.

Airgap increase → Reluctance increases
→ flux reduces
↪ we don't necessarily operate in saturation

* Mutual inductance :-



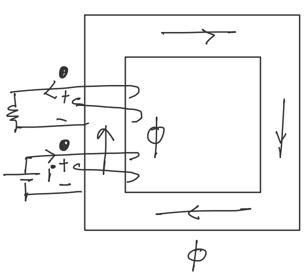
Coupled Coil

Both are same coils

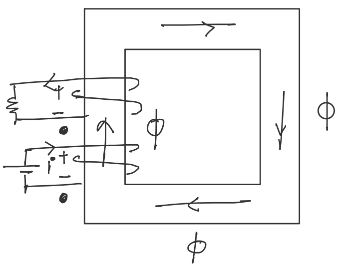
When we apply a dc voltage in coil 1, ϕ is produced. In coil 2, the voltage should be induced such that the current produced by it opposes the flux producing it.

* Dot convention :-

Whatever happens at the dot terminal of one coil, exactly the same thing happens at the dot terminal of second. If one winding has dot terminal as positive, the other coil will have the dot terminal as positive. Same for negative.

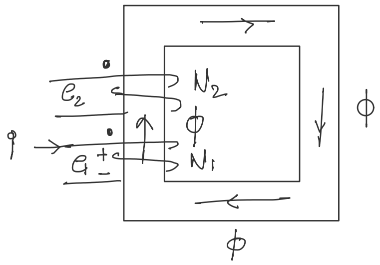


or



Dot means they are the same structure.

If the dot enters one coil and produce the flux in one direction, then if the current enters the dot of the second coil, flux due to it will be produced in the same direction.



$Hl = Ni$

Ques:- $e_2 = f(i_1)$

$$i \rightarrow \underset{(H)}{\frac{N_1 i}{l}} \rightarrow \underset{(B)}{\frac{\mu N_1 i}{l}} \rightarrow \underset{\Phi}{\frac{\mu N_1 i A_c}{l}}$$

$$e_2 = N_2 \frac{d\Phi}{dt}$$

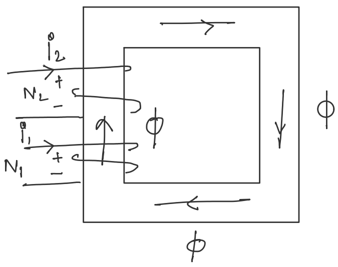
$$e_2 = \frac{N_2 N_1 \mu A_c}{l} \frac{di}{dt}$$

$$M = \frac{N_1 N_2}{R}$$

$$M = \sqrt{L_1 L_2}$$

$$L_1 = \frac{N_1^2}{R}$$

$$L_2 = \frac{N_2^2}{R}$$



$$\oint H \cdot dl = Ni$$

$$Hl = N_1 i_1 + N_2 i_2$$

$$H = \frac{N_1 i_1 + N_2 i_2}{l}$$

$$B = \frac{\mu (N_1 i_1 + N_2 i_2)}{l}$$

$$\phi = \frac{\mu (N_1 i_1 + N_2 i_2) A_c}{l}$$

$$e_2 = N_2 \frac{d\phi}{dt}$$

$$= \frac{\mu N_1 N_2 A_c}{l} \frac{di_1}{dt} + \frac{N_2^2 A_c \mu}{l} \frac{di_2}{dt}$$

$$= \frac{N_1 N_2}{R} \frac{di_1}{dt} + \frac{N_2^2}{R} \frac{di_2}{dt}$$

$$e_2 = M \frac{di_1}{dt} + L_2 \frac{di_2}{dt}$$

Similarly $e_1 = M \dfrac{di_2}{dt} + L_1 \dfrac{di_1}{dt}$