Lecture 4

Tuesday, 18 August 2009
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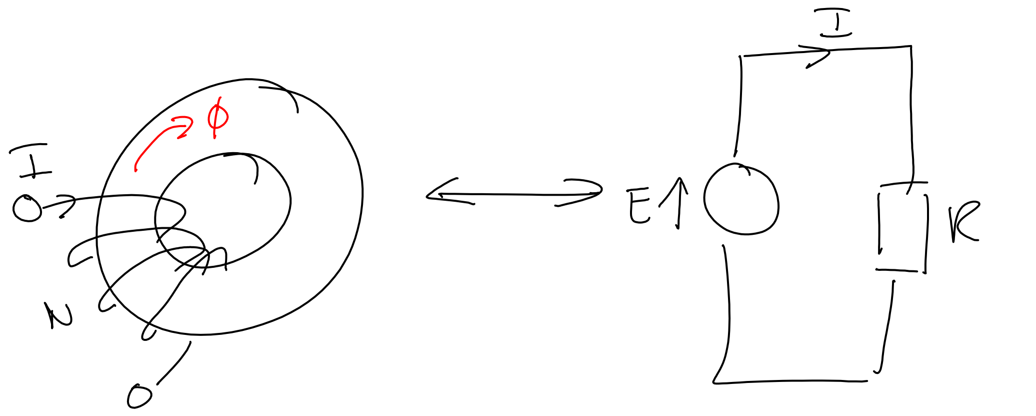
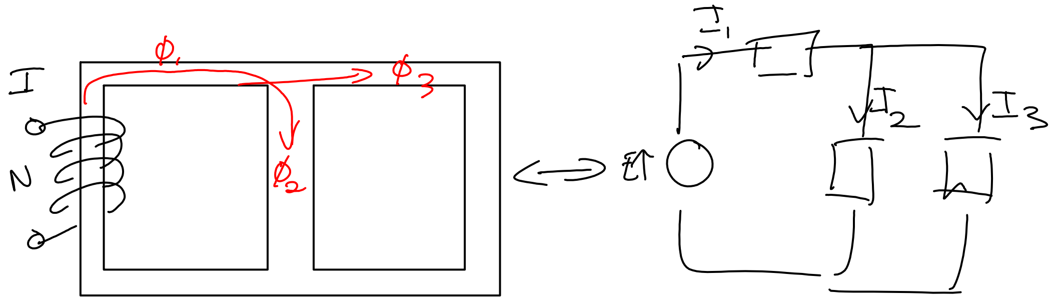
Electric Analogy of the Magnetic Circuit



$\mathcal{F} = \phi \mathcal{R} \longleftrightarrow E = IR$



KCL

$\Sigma \phi = 0$ at a node $\longleftrightarrow$ $\Sigma I = 0$ at a node

KVL $\Sigma \mathcal{F} = \Sigma \phi \mathcal{R}$ around a loop $\longleftrightarrow$ $\Sigma F = \Sigma I R$ around a loop

Parallels between electric and magnetic circuits

Magetic Flux	ϕ	$\Leftrightarrow$	Current	i
mmf	$\mathcal{F}$	$\Leftrightarrow$	electromotive force	$\mathcal{E}$
reluctance	$\mathcal{R}$	$\Leftrightarrow$	resistance	R
flux density	B	$\Leftrightarrow$	Current density	J
Permiability	μ	$\Leftrightarrow$	Conductivity	σ
Magnetic Drop	V_m	$\Leftrightarrow$	Voltage Drop	V
Magnetic Field Intensity	H	$\Leftrightarrow$	Electric Field	E
permiance	P	$\Leftrightarrow$	Conductance	G

Parallel Formulas

$$\phi = \frac{\mathcal{F}}{\mathcal{R}} \quad \Leftrightarrow \quad i = \frac{\mathcal{E}}{R}$$

$$\mathcal{R} = \frac{l}{\mu A} \quad \Leftrightarrow \quad R = \frac{l}{\sigma A}$$

$$B = \mu H \quad \Leftrightarrow \quad J = \sigma E$$

$$V_m = \phi \mathcal{R} \quad \Leftrightarrow \quad V = IR$$

$$B = \frac{d\phi}{dA} \quad \Leftrightarrow \quad J = \frac{dI}{dA}$$

$$P = \frac{1}{\mathcal{R}} = \frac{\mu A}{l} \quad \Leftrightarrow \quad G = \frac{1}{R} = \frac{\sigma A}{l}$$

$$\sum \phi = 0 \quad \Leftrightarrow \quad \sum I = 0$$

$$\sum \mathcal{F} = \sum V_m \quad \Leftrightarrow \quad \sum \mathcal{E} = \sum V$$

linear case $\sum \mathcal{F} = \sum \phi \mathcal{R} \quad \Leftrightarrow \quad \sum \mathcal{E} = \sum IR$

Additional equation for magnetic CCTs

$$\mathcal{F} = NI$$

Two classes of problems.

i) linear CCTs

ii) non-linear CCTs

Linear

- μ for each portion of the magnetic CCT is assigned a value and is then considered to be linear for the range of H involved.
- This allows constant values of $\mathcal{R}$ and $\mathcal{F}$ to be calculated.
- The equation $\mathcal{F} = \phi \mathcal{R}$ may then be used to solve the problem.
- The fixing of μ is effectively the linearication of the B-H curve
  ie saturation is neglected

Non-Linear Class

- In these cases, graphical relationships of B vs H are given for the magnetic CCT and it may be necessary to integrate to get a solution.