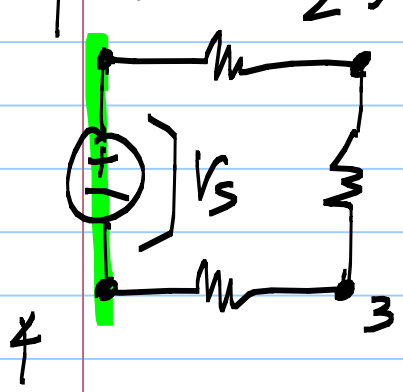
EC1010: Lecture 41 — Magnetic circuits

KVL

$$\oint \bar{E} \cdot d\bar{l} = 0$$



$$\int_1^2 \bar{E} \cdot d\bar{l} + \int_2^3 \bar{E} \cdot d\bar{l} + \int_3^4 \bar{E} \cdot d\bar{l}$$

$$V_{12} \qquad V_{23} \qquad V_{34}$$

$$= \int_1^4 \bar{E} \cdot d\bar{l}$$

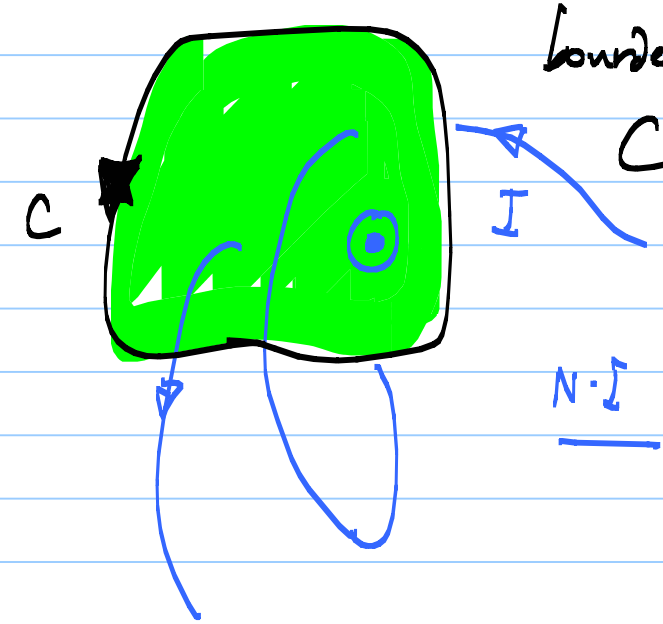
$$V_{12} + V_{23} + V_{34} = V_s$$

Magnetic field

$$\oint_C \bar{H} \cdot d\bar{l} = I_{tot}$$

$$\int \bar{J} \cdot d\bar{s}$$

cutting the surface bounded by C

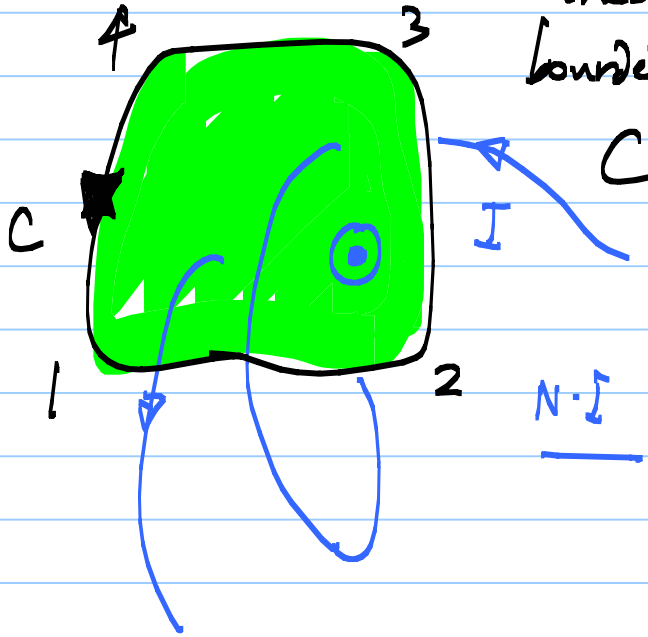


$N \cdot I$

Magnetic field

$$\oint_C \bar{H} \cdot d\bar{l} = I_{tot}$$

$\int \bar{J} \cdot d\bar{s}$ cutting the surface bounded by C



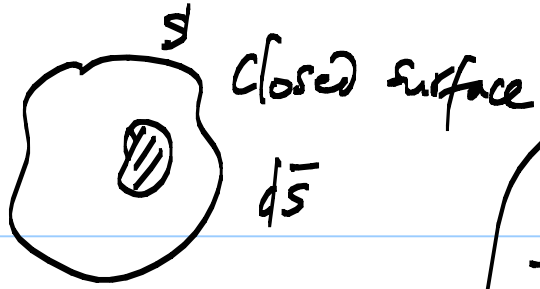
$$\int_1^2 \bar{H} \cdot d\bar{l} + \int_2^3 \bar{H} \cdot d\bar{l} + \int_3^4 \bar{H} \cdot d\bar{l} + \int_4^1 \bar{H} \cdot d\bar{l}$$

Magnetomotive force $\mathcal{F}$ $= NI \left(I_{tot} \right)$

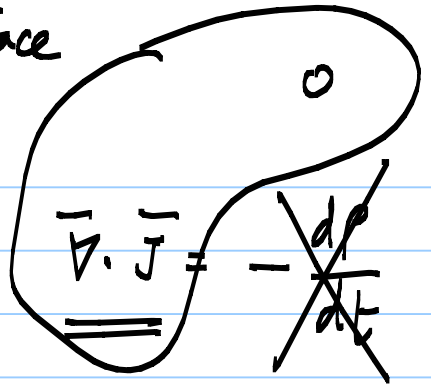
$$\mathcal{F}_{12} + \mathcal{F}_{23} + \mathcal{F}_{34} + \mathcal{F}_{41} = NI$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \qquad \int \vec{E} \cdot d\vec{l}$$

$$\nabla \times \vec{B} = \mu_0 \vec{J} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$$

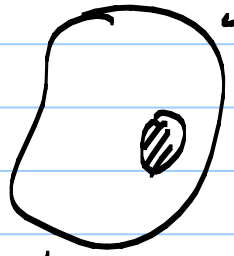


KCL



Total current entering (leaving) $\bar{J} \cdot d\bar{s}$

the surface = 0



$\bar{\nabla} \cdot \bar{B} = 0$

Flux density

$\bar{B} \cdot d\bar{s}$

Flux

~ KCL

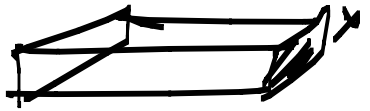
Total flux entering (leaving)

the surface = 0

V: Voltage: KVL (across variable)

I: Current: KCL (thru variable)

$V = I \cdot R$



$V = \left(\rho \cdot \frac{l}{A}\right) I$

Conductance

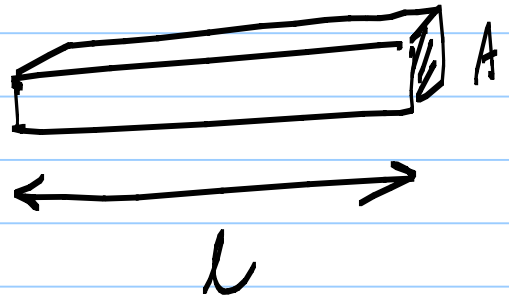
$I = \left(\sigma \cdot \frac{A}{l}\right) \cdot V$

$\phi = B \cdot A$

$\mathcal{F} = H \cdot l$

Linear magnetic material:

$B = \mu_r \mu_0 \cdot H$



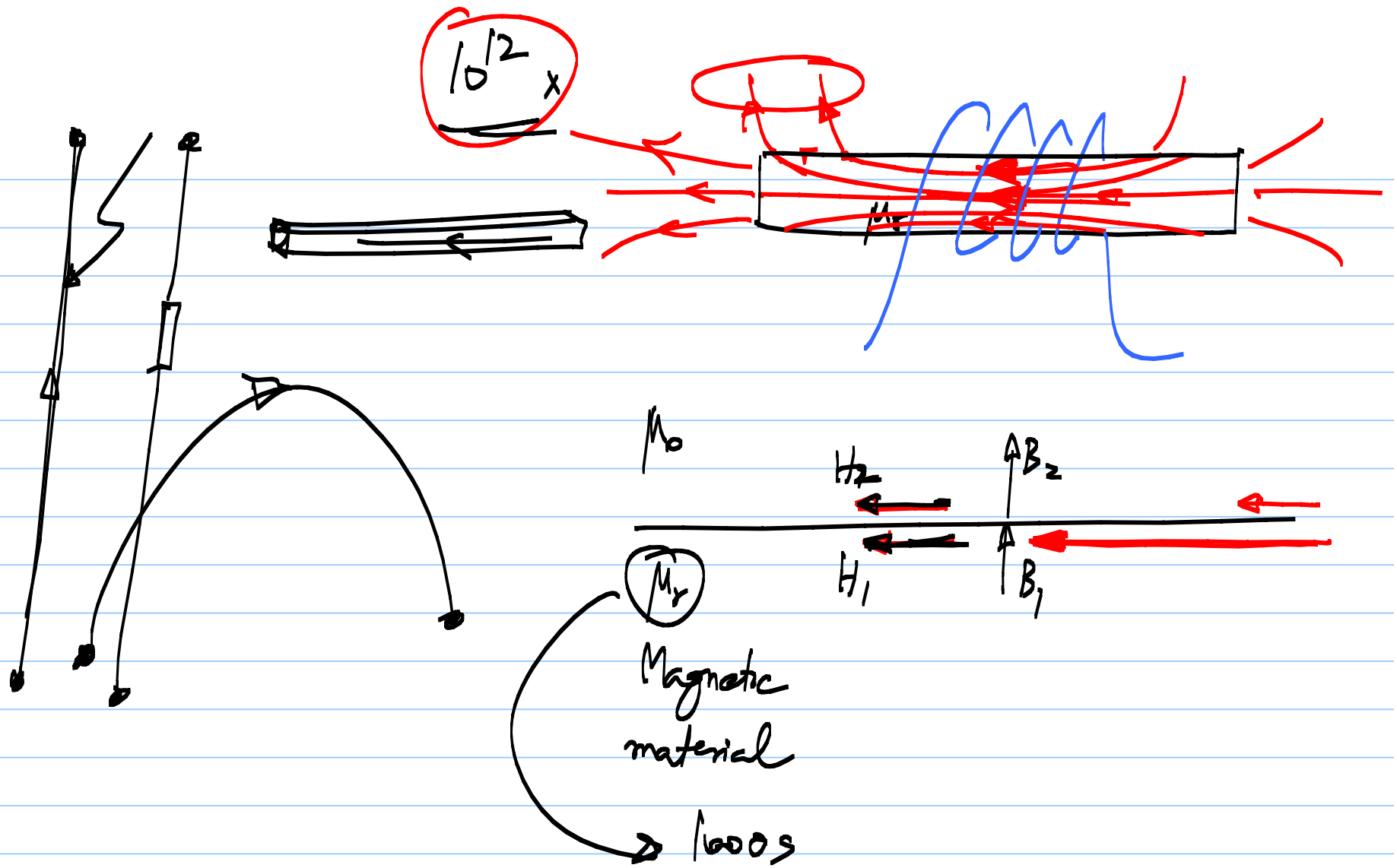
$\mathcal{R} = \frac{1}{\mu_r \mu_0} \cdot \frac{l}{A}$

Reluctance

$\mathcal{P} = \mu_r \mu_0 \frac{A}{l}$ (permeance)

$\frac{\phi}{A} = \mu_r \mu_0 \cdot \frac{\mathcal{F}}{l}$

$\phi = \left(\mu_r \mu_0 \cdot \frac{A}{l}\right) \mathcal{F}$


10^{12} x
μ_r
μ_0
H_2
B_2
H_1
B_1
μ_r
Magnetic material
1000s