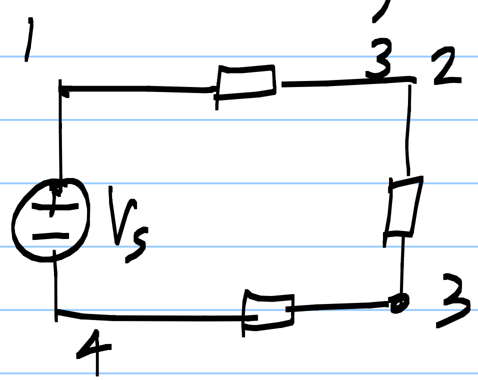
Lecture 39

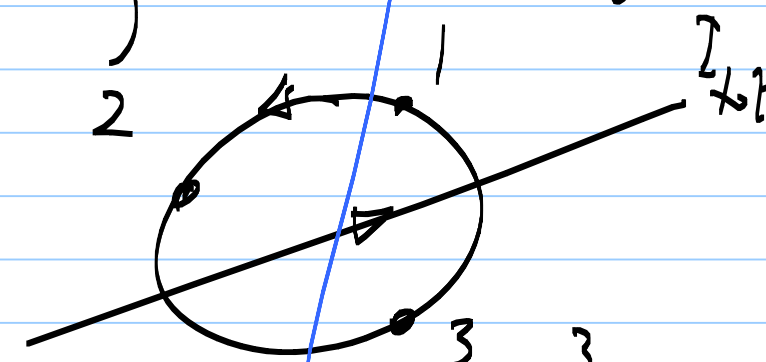
$$\oint \bar{E} \cdot d\bar{l} = 0 \quad \longleftrightarrow \quad \oint \bar{H} \cdot d\bar{l} = I_{tot}$$

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

Applied voltage

Voltage drops





$$I_{tot} = \int_1^2 \bar{H} \cdot d\bar{l} + \int_2^3 \bar{H} \cdot d\bar{l} + \int_3^1 \bar{H} \cdot d\bar{l}$$

Applied MMF

Magnetomotive force drops

KCL: $\oint_{C'} \bar{J} \cdot d\bar{s} = 0$ $\oint_{c} \bar{B} \cdot d\bar{s} = 0$

(no charge accumulation)

$\int_{s} \bar{J} \cdot d\bar{s} = I$ (through s)

$\int_{s} \bar{B} \cdot d\bar{s} = \phi$ (through s)

MMF: $\mathcal{F}$

$\bar{B} = \mu_r \mu_0 \bar{H}$; $\phi = \int_s \bar{B} \cdot d\bar{s}$; $\oint \bar{H} \cdot d\bar{l} = I_{tot}$

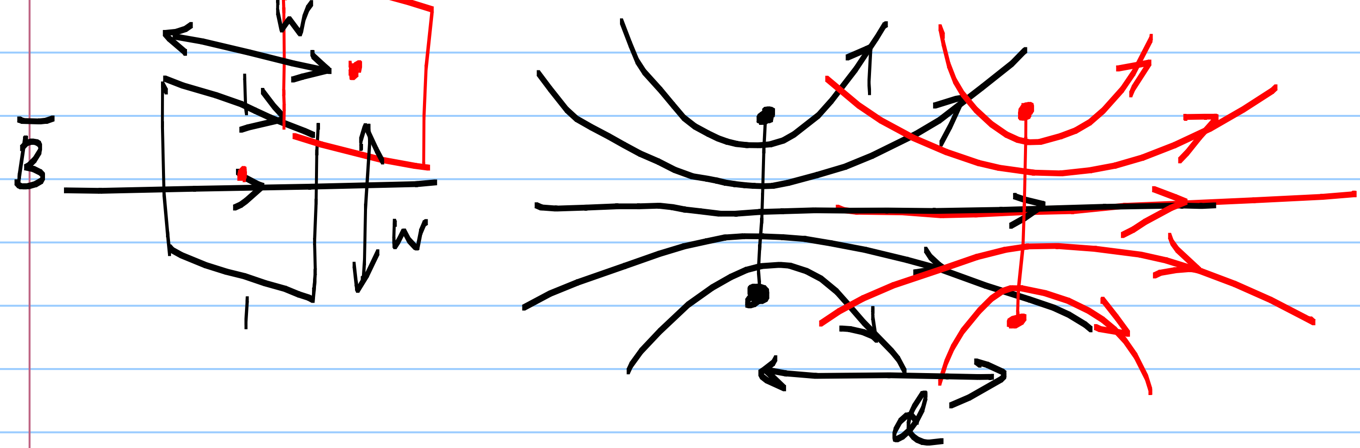
Magnetic field (Flux density) — Wb/m^2 = Tesla

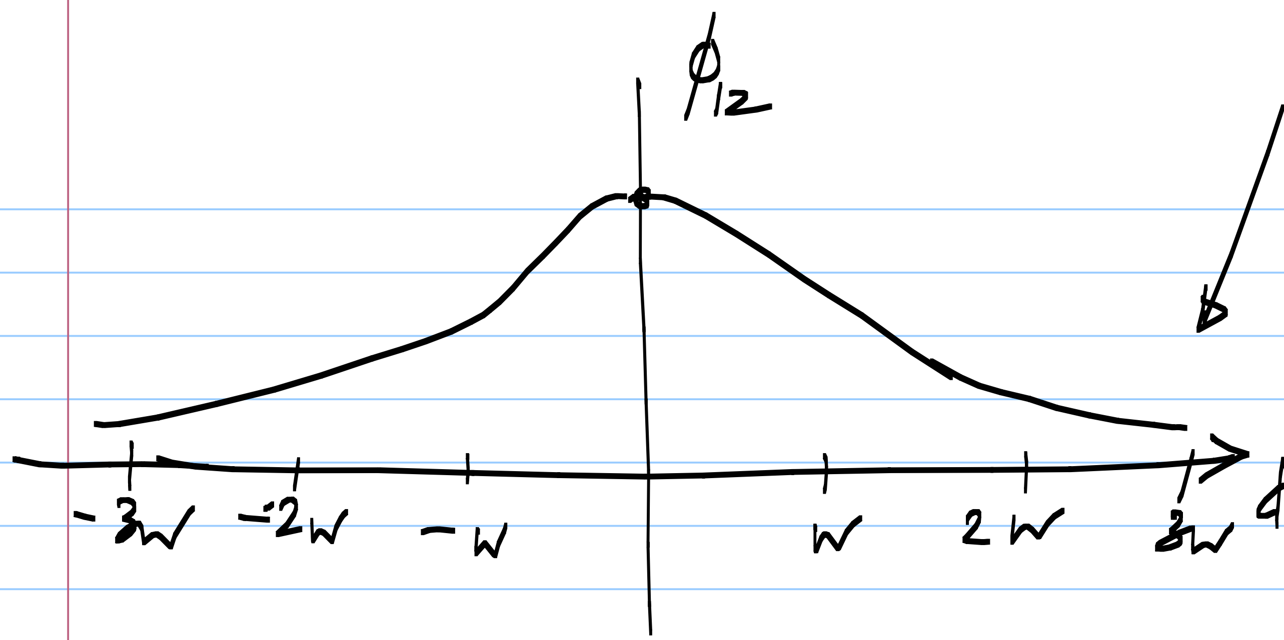
(Wb) (weber)

A·t/m

Magnetic field A/m

Applied MMF



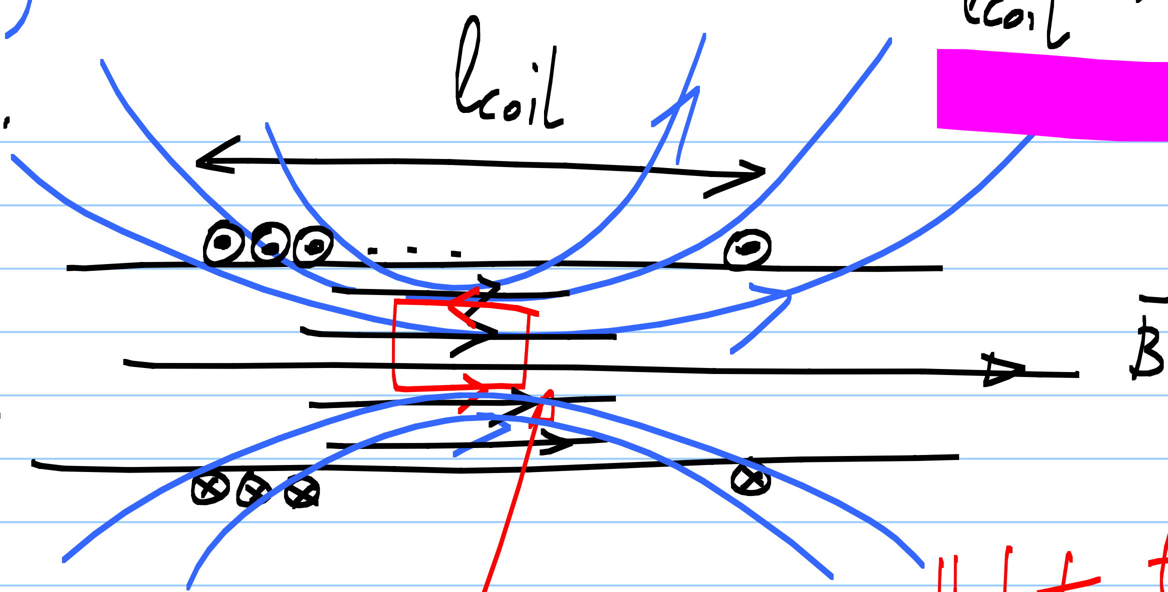


Negligible coupling if

$d > 3w$

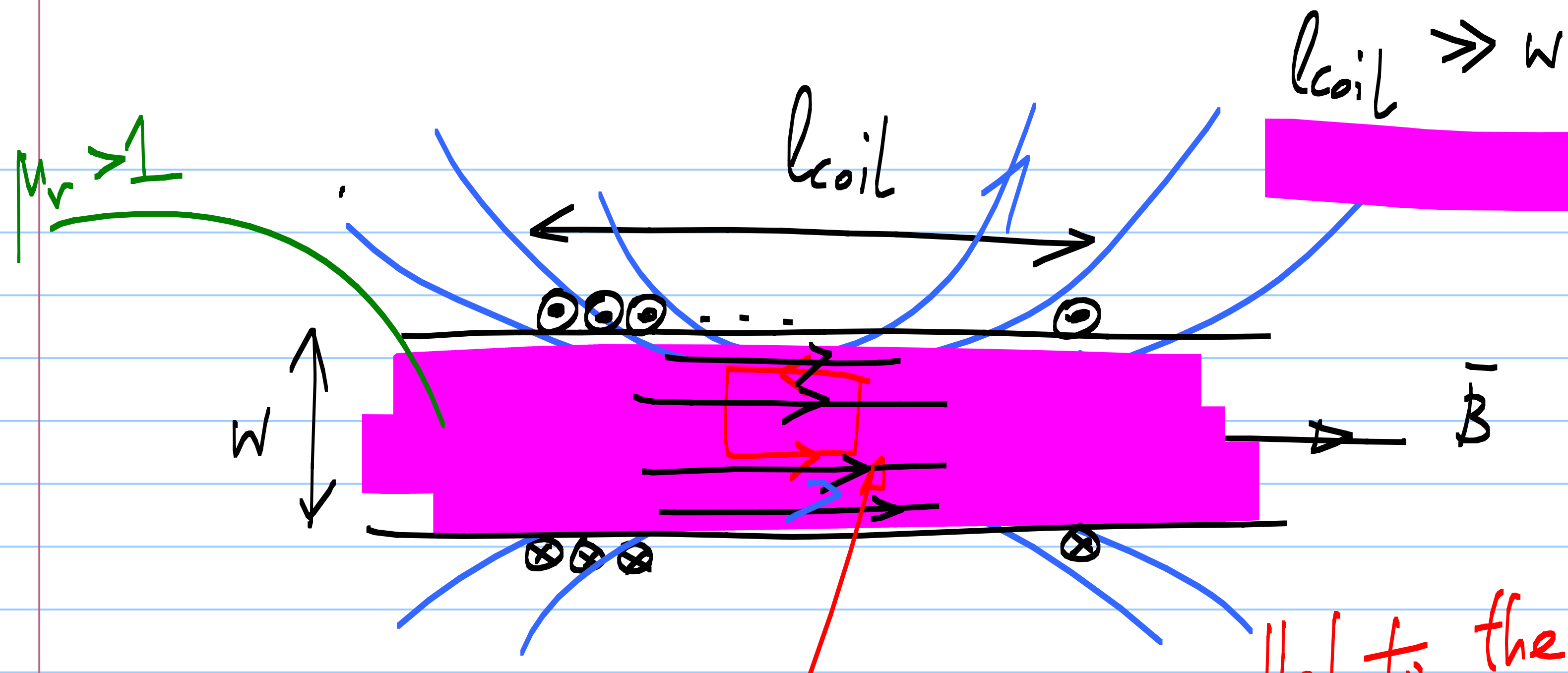
(air core) Solenoid.

$l_{coil} \gg W$



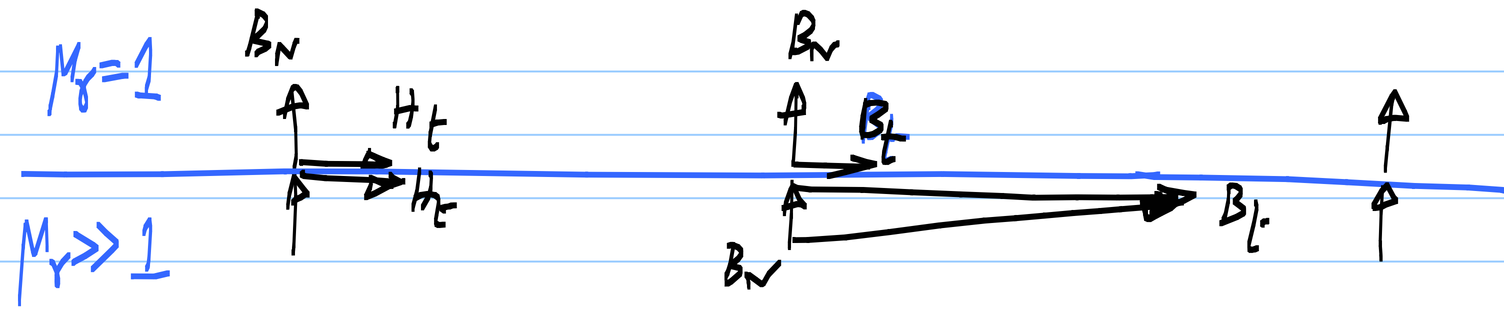
$\bar{B}$: uniform, parallel to the axis of the solenoid

$$L = \frac{\mu_0 N^2 \cdot A}{l_{coil}}$$

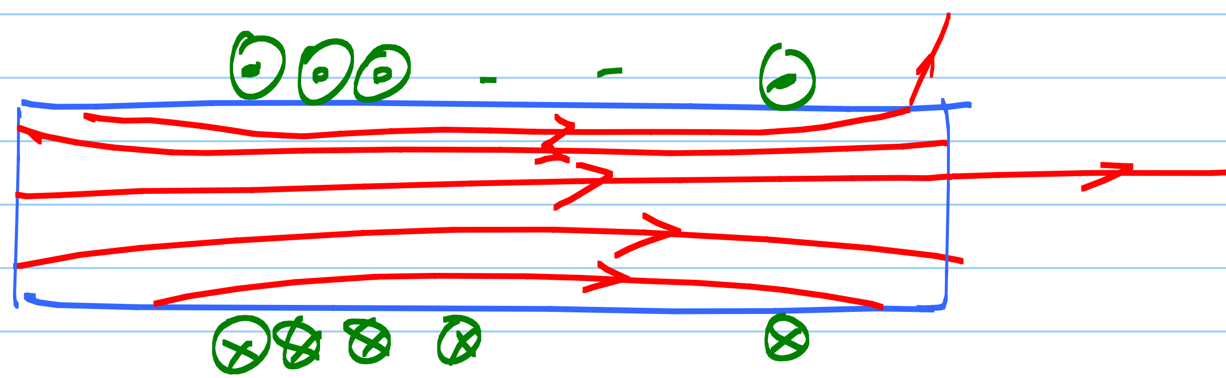


$\bar{B}$: uniform, parallel to the axis of the solenoid

$$L = \frac{\mu_r \mu_0 N^2 \cdot A}{l_{coil}}$$

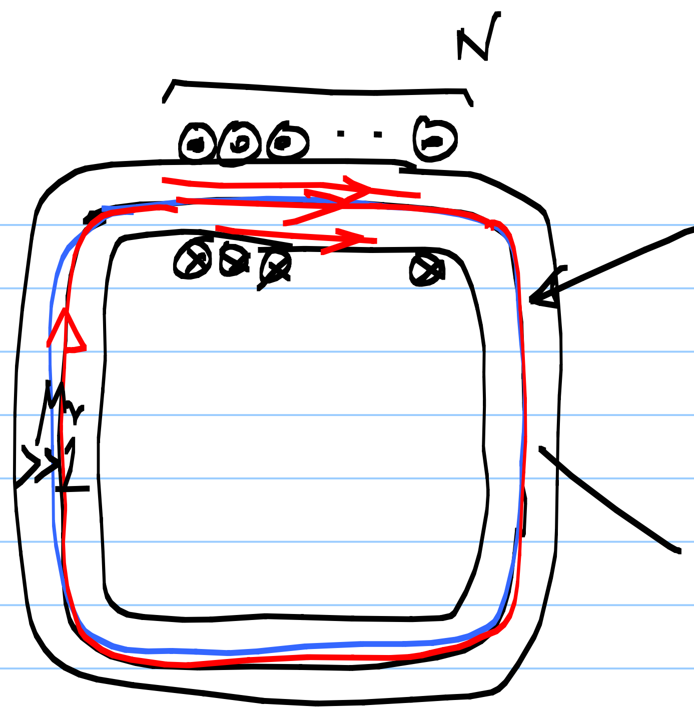


$\mu_r = 1$
$\mu_r \gg 1$
B_N
H_t
H_t
B_N
B_t
B_N
B_t



Applied MMF

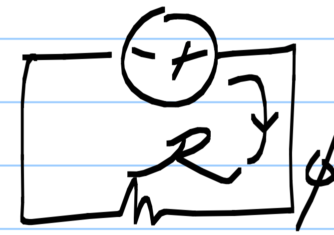
$\mathcal{F} = NI.$



l_{loop} $\mathcal{F}$

Cross sectional area A

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



$$H \cdot l_{loop} = N \cdot I$$

$$\mathcal{F} = N \cdot I$$

$$H = \frac{NI}{l_{loop}}$$

$$B = \mu_r \mu_0 \frac{NI}{l_{loop}}$$

$$\phi = B \cdot A = \mu_r \mu_0 \cdot \frac{NA}{l_{loop}} \cdot I$$

$$\psi = \mu_r \mu_0 \frac{N^2 A}{l_{loop}} \cdot I$$

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

$$\frac{\mathcal{F}}{\phi} = \frac{l_{loop}}{\mu_r \mu_0 A} = \mathcal{R} \text{ (reluctance)}$$

$$\equiv$$

$$\frac{V}{I} = \frac{l_R}{\sigma \cdot A}$$

$$\frac{1}{\mathcal{R}} = \mathcal{P} \text{ (permeance)}$$