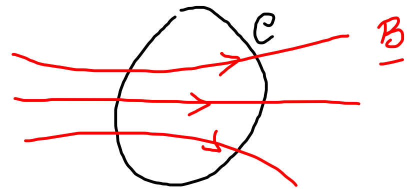
$$f.e.m. = -\frac{d\Phi_S(\underline{B})}{dt}$$



Campi $\underline{E}$ e $\underline{B}$ statici

$$\int_S \underline{E}\cdot d\underline{S} = q^{int}/\varepsilon_0$$

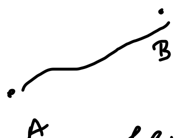
$$\oint_C \underline{E}\cdot d\underline{l} = 0$$

C. elettrico statico è conservativo

$$\int_S \underline{B}\cdot d\underline{S} = 0$$

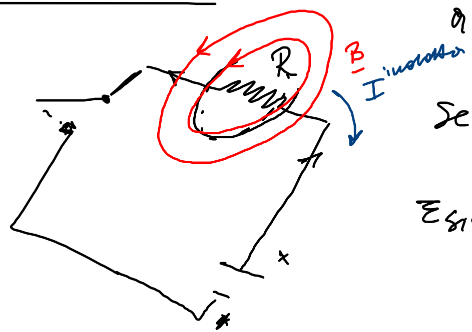
$$\oint_C \underline{B}\cdot d\underline{l} = \mu_0 I^{conc}$$

$$f_{em} = -\int_A^B \underline{E}\cdot d\underline{l}$$



$$f_{em} = \oint_C \underline{E}\cdot d\underline{l} \Rightarrow \oint_C \underline{E}\cdot d\underline{l} = -\frac{d\Phi_S(\underline{B})}{dt}$$

Fenomeni di auto-induzione



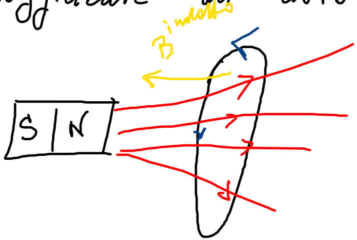
a regime $I = \frac{fem}{R}$

Se scorre I, si genera $\underline{B}$ auto indotto

Esiste un $\Phi_S(\underline{B})$; $\frac{d\Phi_S(\underline{B})}{dt} \neq 0$

Legge di F-N-L : $fem = -\frac{d\Phi_S(\underline{B})}{dt}$

L : coefficiente di auto-induzione



$$fem = -\frac{d\Phi(\underline{B} = \underline{B}^{ext} + \underline{B}^{int})}{dt} = -\frac{d\Phi_S(\underline{B}^{ext})}{dt} - \frac{d\Phi_S(\underline{B}^{auto})}{dt}$$

$B^{int/auto}$

$$\int_S (\underline{B}^{int} + \underline{B}^{ext}) \cdot d\underline{S} = \int_S \underline{B}^{int} \cdot d\underline{S} + \int_S \underline{B}^{ext} \cdot d\underline{S}$$

$$f_{em} = -\frac{d\Phi_S(\underline{B}^{auto})}{dt}$$

ricapitolo: $\Phi_S(\underline{B}^{auto}) \propto B^{auto} \propto I$

I: corrente che scorre

$$\Phi_S(\underline{B}^{auto}) = L \cdot I \Rightarrow \boxed{\frac{d\Phi_S(\underline{B}^{auto})}{dI} = L}$$

$$f_{em} = -\frac{d\Phi_S(\underline{B}^{auto})}{dt} = -\frac{d\Phi_S(\underline{B}^{auto}(I(t)))}{dI}\frac{dI}{dt} = -L\frac{dI}{dt}$$

L rappresenta la propensione del circuito a produrre una forza contro e.m., cioè ad ostacolare la salita della corrente

$$C = \frac{Q}{\Delta V} \; ; \; Q = C\Delta V$$

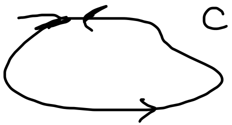
$$[L] = \frac{T \cdot m^2}{A} = \text{Henry} \quad H$$

$L \sim mA$

L: dipende dalla geometria del dispositivo, ~~no da I~~

Come si calcola

$$L = \frac{d\Phi_S(\underline{B}^{auto})}{dI}$$



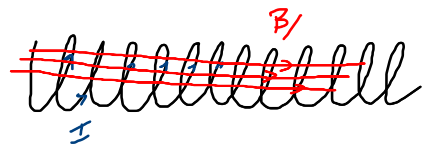
1) Immagino di fare scorrere una corrente I nel circuito di interesse

2) Devo calcolare il campo magn. $\underline{B}^{auto}$ prodotto da I

3) " " il $\Phi_S(\underline{B}^{auto})$ attraverso la sup. di C

4) Calcolare $\dfrac{d\Phi_S(\underline{B}^{auto})}{dI}$ – mi aspetto che $\Phi_S(\underline{B}^{auto}) \propto I$

Es. autoinduttanza del solenoide



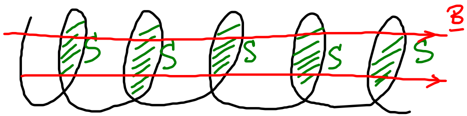
2) $\underline{B}$ lungo l'asse

B è uniforme

$$B = \mu_0 \frac{N}{L} \cdot I$$

$\frac{N}{L}$ = spire/metro

3) $\Phi_S(\underline{B})$

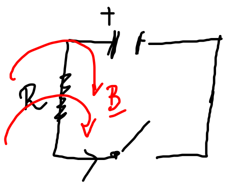


Sup. del solenoide $= N \cdot S$

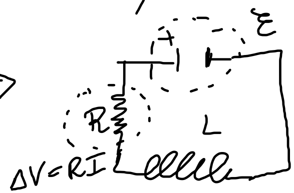
$$\phi = (\text{sup. sol.}) \times B^{auto} = N \cdot S \cdot \mu_0 \frac{N}{L} \cdot I = \mu_0 \frac{N^2}{L} S I$$

4) $$L = \frac{d\phi}{dI} = \mu_0 \frac{N^2 S}{L}$$

Salita della corrente in un dispositivo con $L \neq 0$



$\Longrightarrow$



$$\underbrace{\oint_C \underline{E} \cdot d\underline{l}}_{\text{cadute/salite di potenziale lungo il circuito}} = \overbrace{-\frac{d\Phi_S(B^{auto})}{dt}}^{L\, dI/dt}$$

$$\mathcal{E} - \Delta V_R = L \frac{dI}{dt}$$

$$\mathcal{E} = \underbrace{RI}_{\Delta V_R} + L \frac{dI}{dt}$$

Se $\frac{dI}{dt} = 0$: $\mathcal{E} = RI$ legge di Ohm

$I = \mathcal{E}/R$

$\rightarrow$ eq. differenziale con l'incognita $I = I(t)$

Soluzione per separazione di variabili

$$\frac{dt}{\mathcal{E}-RI} \times \mathcal{E} - RI = L\frac{dI}{dt} \times \frac{dt}{\mathcal{E}-RI} \;; \quad dt = L\frac{dI}{\mathcal{E}-RI} \;; \quad \frac{dt}{L} = \frac{dI}{\mathcal{E}-RI}$$

$$\frac{dt}{L/R} = \frac{dI}{\mathcal{E}/R - I}$$

$\rightarrow$ dimensioni di un tempo

$$-\int_0^t \frac{dt}{\tau} = +\int_0^{I(t)} \frac{dI}{-\mathcal{E}/R + I}$$

$$\ln I - \mathcal{E}/R \Big|_0^{I(t)} = -t/\tau \Big) \qquad \tau \overset{def}{=} L/R$$

$$\ln\left(I - \frac{\mathcal{E}}{R}\right) - \ln\left(-\frac{\mathcal{E}}{R}\right) = -t/\tau$$

$$\ln\left(\frac{\mathcal{E}/R - I}{\mathcal{E}/R}\right) = -t/\tau \; ; \quad \frac{\mathcal{E}}{R} - I = \frac{\mathcal{E}}{R} e^{-t/\tau} \; ; \quad I(t) = \frac{\mathcal{E}}{R}\left(1 - e^{-t/\tau}\right)$$

$$\lim_{t \to +\infty} I(t) = \frac{\mathcal{E}}{R}$$

Dopo $t = 5\tau$ $\quad I(t) \approx 99\% \cdot \frac{\mathcal{E}}{R}$

$$\tau = \frac{L}{R} \quad \propto L$$