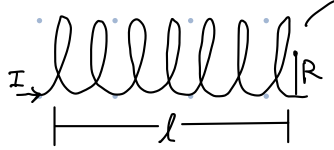
Capacitance: $C=\frac{Q}{V}$

Inductance: $\boxed{L=\frac{\Phi_B}{I}}$

Inductance(L) of a solenoid:

N - Number of turns



$L=\frac{\Phi_B}{I}$ $\quad$ $\Phi_B=\int\vec{B}\cdot d\vec{A}$

$=\int B\,dA\cos\theta$ $\quad$ The Φ_B inside the solenoid is Φ_B of 1 loop times the number of loops.

$L=\frac{BAN}{I}$ $\quad$ uniform inside the solenoid/over the area $=B\int dA = BAN$

$L=\frac{\mu_0 n I A N}{I}$ $\quad$ B for a solenoid $=\mu_0 n I$

$=\mu_0 n A N$ $\quad$ $n=\frac{N}{l}$

$L=\frac{\mu_0 A N^2}{l}$

Voltage across an inductor: It's the same as the back Emf.

$|\mathcal{E}mf| = \left|-\frac{d\Phi_B}{dt}\right|$ $\quad$ $L=\frac{\Phi_B}{I}\rightarrow\Phi_B=LI$

$=\frac{d(LI)}{dt}$

Inductance usually is constant. $=L\frac{dI}{dt}$

$\boxed{V_L=L\frac{dI}{dt}}$

Energy ($\mathcal{U}_L$) in an inductor

$$P = \frac{d\mathcal{U}_L}{dt} = \frac{d(q\Delta V)}{dt} = \frac{dq}{dt}V_L = I V_L = I\left(L\frac{dI}{dt}\right)$$

$$\frac{d\mathcal{U}_L}{\cancel{dt}} = IL\frac{dI}{\cancel{dt}} \rightarrow d\mathcal{U}_L = IL\,dI$$

$$\int d\mathcal{U}_L = \int LI\,dI$$

$$\mathcal{U}_L = \frac{1}{2}LI^2$$

Energy density (u_B) of an inductor:

- Write $\mathcal{U}_L$ in terms of B.

$$n = \frac{N}{l}$$

$$L = \frac{\mu_0 A N^2}{l} \qquad B = \mu_0 n I \Rightarrow I = \frac{B}{\mu_0 n} = \frac{Bl}{\mu_0 N}$$

$$\mathcal{U}_L = \frac{1}{2}LI^2 = \frac{1}{2}\left(\frac{\mu_0 A N^2}{l}\right)\left(\frac{Bl}{\mu_0 N}\right)^2$$

$$= \frac{1}{2}\left(\frac{\cancel{\mu_0} A \cancel{N^2}}{\cancel{l}}\cdot\frac{B^2 l^{\cancel{2}}}{\mu_0^{\cancel{2}}\cancel{N^2}}\right)$$

Volume of the solenoid

$$= \frac{1}{2}\frac{B^2}{\mu_0}(Al)$$

$$\boxed{u_B = \frac{1}{2}\frac{B^2}{\mu_0}} \qquad \boxed{\mathcal{U}_L = \int u_B \, dVol}$$