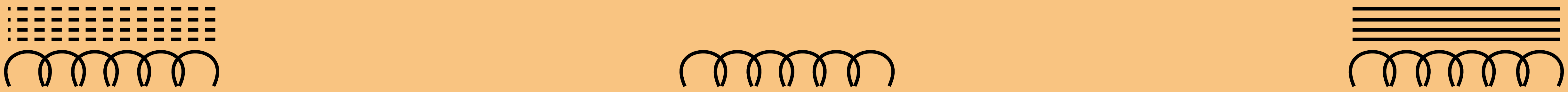
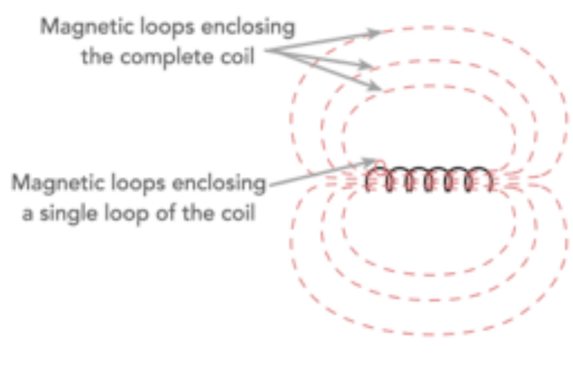
Basics of Inductance

Self inductance is defined as the phenomenon in which a change in electric current in a circuit produces an induced electro-motive-force in the same circuit.

The unit of inductance is the ***Henry.***
The self-inductance of a coil is said to be one henry if a current change of one ampere per second through a circuit produces an electro-motive force of one volt in the circuit.



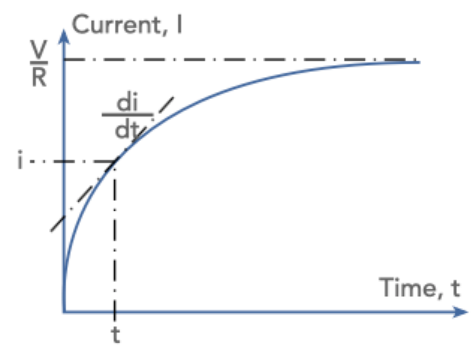
$$V_L = -N\frac{d\phi}{dt}$$



VL = induced voltage in volts
N = number of turns in the coil
dφ/dt = rate of change of magnetic flux in webers / second

The induced voltage in an inductor may also be expressed in terms of the inductance (in henries) and the rate of change of current.

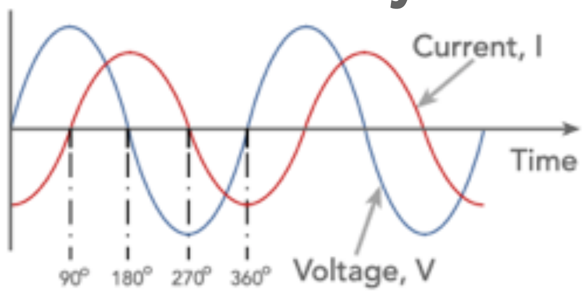
$$V_L = -L\frac{di}{dt}$$



Voltage & current in an inductive only circuit

Vt = sin (ω t)

It = sin (ω t)



Wire inductance calculations

The theoretical inductance of the internal plus external inductance of a straight length of wire at low frequencies can be taken to be:

$$L_{dc} = 2l\left(\log_e\left(2\frac{l}{r}\right) - 0.75\right)$$

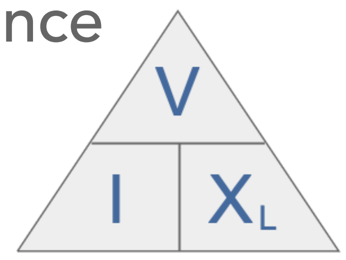
For high frequencies the skin effect means that the internal inductance tends to zero & the overall high frequency inductance formula becomes:

$$L_{hf} = 2l\left(\log_e\left(2\frac{l}{r}\right) - 1.0\right)$$

Ldc = low frequency inductance in nanohenries
Lhf = high frequency inductance in nanohenries
l = length of wire in cm
r = radius of the wire in cm

Ohms law for inductive reactance

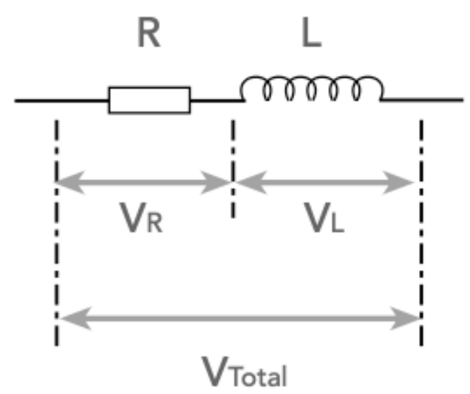
$$X_L = \frac{V}{I}$$

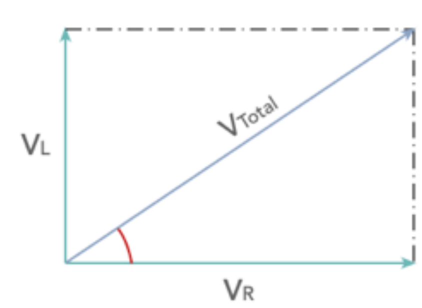


Ohm's law applies to inductive reactances. If a resistance is also present, then this must be added vectorially as detailed below.

Adding inductive reactance & resistance

When adding resistance to an inductive impedance, this must be done vectorially because of the phase of the current in the capacitor.





Total impedance $Z = \sqrt{R^2 + X_L{}^2}$

Inductive reactance Xc $= \omega L$

$= 2\pi f L$

XL is the inductive reactance in ohms
L is the inductance in henries
f is the frequency in Hertz