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.







Vt = sin (ω t)

It = sin (ω t - $\pi/2$)

 $\label{eq:VL} \begin{array}{l} \text{VL} = \text{induced voltage in volts} \\ \text{N} = \text{number of turns in the coil} \\ \text{d} \phi/\text{d} t = \text{rate of change of magnetic} \\ & \text{flux in webers / second} \end{array}$



180° 270° 360° Voltage, V

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





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:

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

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

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

Ldc = low frequency inductance in nanohenries

Ohms law for inductive reactance





Current, I

Time

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

Voltage & current in an inductive only circuit

90⁰

Inductive reactance
$$Xc = \omega L$$

$$= 2 \pi f$$

XL is the inductive reactance in ohms L is the inductance in henries f is the frequency in Hertz Lhf = high frequency inductance in nanohenries I = length of wire in cm r = radius of the wire in cm

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.



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