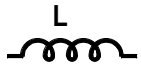
The unit of inductance is the Henry and the circuit symbol used for the inductor is:—



A rate of change of current of one amp per second through an inductor of one Henry gives a voltage across the inductor of one volt.

Current flowing through an inductor:—

$$I = I_0 \sin(2\pi f t)$$

$$\text{then} \quad V = L 2\pi f I_0 \sin(2\pi f t + \frac{\pi}{2})$$

Law of electromagnetic induction, Lenz's law
Rate of change of magnetic flux in a coil and the induced emf:—

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

where the unit of inductance, L, is the Henry.

Apply a sinusoidal voltage across an inductor so as to give a current in the inductor

$$I = I_0 \sin(2\pi f t)$$

then from Lenz's law, this externally applied voltage is opposed by the induced emf :—

$$\begin{aligned} V &= -\mathcal{E} \\ &= L\frac{dI}{dt} \\ &= L\frac{d}{dt}(I_0 \sin(2\pi f t) \\ &= L2\pi f I_0 \cos(2\pi f t) \\ &= L2\pi f I_0 \sin(2\pi f t + \frac{\pi}{2}) \\ &= L\omega I_0 \sin(\omega t + \frac{\pi}{2}) \end{aligned}$$

where $\omega = 2\pi f$ is the angular frequency

- Air cored inductors, Inductance in μH is

$$L(\mu H) = \frac{d^2 n^2}{46d + 102b}$$

where n is the number of turns,
d is the coil diameter in cms
b is the length of the coil in cms.

- Ferrite cored inductors have higher values for L because of the higher magnetic permeability of the ferrite core.
A typical formula would be:—

$$L(\text{in nH}) \quad = n^2 A_L^2$$

where n is the number of turns of wire
A_L is a parameter called the Inductance Factor.

Example

A sinusoidally varying current of $2mA$ amplitude and frequency 3kHz passes flows in a 10mH coil. Calculate the voltage and plot the I and V waveforms.

$$\begin{aligned} V &= L\frac{d}{dt}\left(I_0 \sin\left(2\pi f t\right)\right) = L2\pi f I_0 \sin\left(2\pi f t + \frac{\pi}{2}\right) \\ &= 0.01 \times \pi 6000 \times .002 \times \sin(2\pi 3 \times 10^3 \times t + \frac{\pi}{2}) \\ &= 0.377 \sin(18840t + 1.57) \end{aligned}$$