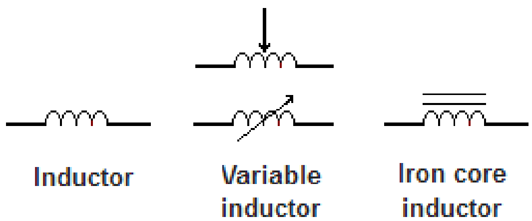
Inductor

An **Inductor** is a passive component that resists changes in current flow. The measurement of inductance is in Henrys. There are a variety of inductor components, fixed, variable, or dependent on electrical or mechanical influences.

Inductor Symbols



Inductance

Inductance occurs from a magnetic field around a current carrying conductor. When a current flows through a coil of wire, a magnetic field develops from the coil. A decrease in current will result in the collapse of the magnetic field, which will induce current flow in the same direction of the existing current flow. An increase of current will increase this magnetic field. Adding an iron core to the coil will magnify the inductance of the coil. The building and collapsing magnetic fields will oppose changes in current (Lenz's law). Inductance is determined by the magnetic flux (ϕ) from the coil is created by instantaneous current i.

$$L = \frac{\emptyset}{i} = \frac{d\emptyset}{di}$$

Faradays Law

Faraday's law of induction – voltage induced by change in magnetic flux of the coil

$$v = \frac{d\emptyset}{dt}$$

Putting it together

$$v = \frac{dLi}{dt} = L\frac{di}{dt}$$

Inductor Impedance

The impedance of an inductor is in reactance. Inductor reactance is the ratio of peak voltage and current of an inductor with a magnetic field.

$$X_L = \frac{V_{PK}}{I_{PK}} = \frac{2\pi f L I_{PK}}{I_{PK}}$$

$$X_L = 2\pi f L$$

Here, we can see that the higher the frequency of changing current, the higher the reactance. With a frequency of zero, such as direct current, the reactance is zero.

Usually, the impedance of the inductor is treated as all reactance, but in the real world, inductors will have resistance as well, resistance of the coil wire. This resistance compared to reactance will be small to insignificantly small. The significance is dependent on number of turns, size of wire, and the frequency where the inductor is used for.

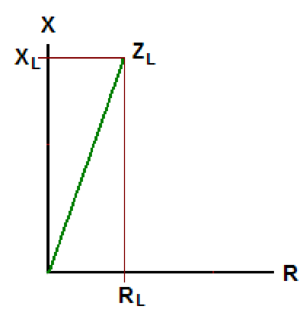
Impedance is the measure of the opposition to current when voltage is applied. Impedance is composed of both resistive and reactive components.

$$Z = R + jX$$

Where Z is impedance, R is resistance, and X is reactance. For the inductor, the impedance is:

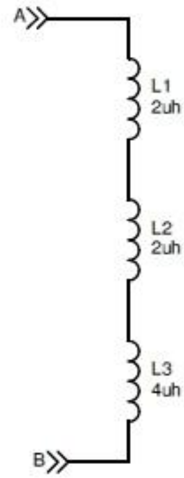
$$Z_L = R_L + jX_L$$

$$Z_L = \sqrt{{R_L}^2 + {X_L}^2}$$



Inductor Circuits

Inductors in series

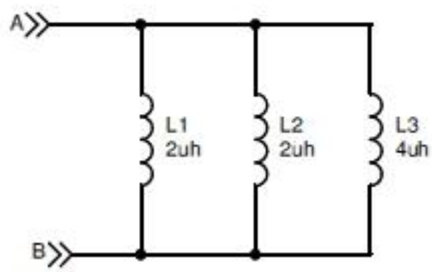


$$L_{Total} = L_1 + L_2 + \ldots + L_N$$

$$L_{Total} = 2uh + 2uh + 4uh$$

$$L_{Total} = 8uh$$

Inductors in Parallel



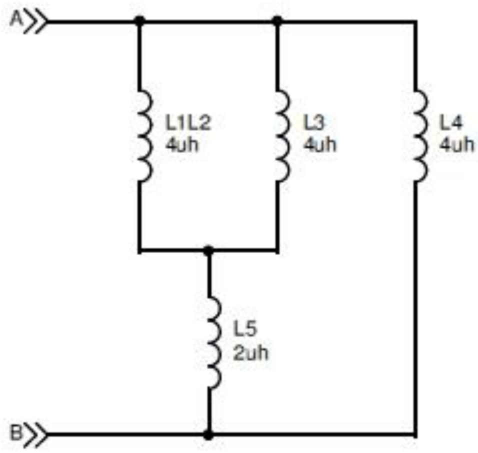
$$\frac{1}{L_{Total}} = \frac{1}{L_1} + \frac{1}{L_2} + \cdots + \frac{1}{L_N}$$

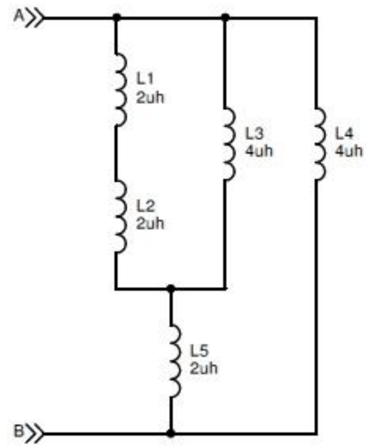
$$\frac{1}{L_{Total}} = \frac{1}{2uh} + \frac{1}{2uh} + \frac{1}{4uh}$$

$$L_{Total} = \frac{1}{\frac{1}{2uh} + \frac{1}{2uh} + \frac{1}{4uh}}$$

$$L_{Total} = 0.8uh = 800nh$$

Mixed Series and Parallel Inductors





First complete the series Inductors, then parallel. Here, L1 and L2 are added together, then with L3