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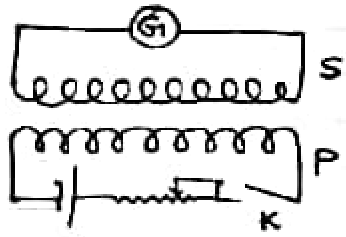
Mutual and Self Inductance

Mutual Inductance: Let us consider two coils P and S as shown in fig.



Let ϕ be the magnetic flux linked with the coil S when a current i flows through the coil P.

$$\therefore \phi \propto i$$

$$\text{or } \phi = Mi \quad \text{---} \quad (1)$$

where M is a constant called the mutual inductance between two coils.

If $i = 1$, then $\phi = M$

The mutual inductance of two circuits is thus defined as the magnetic flux linked with one due to unit current flowing in the other. Differentiating (1) we have

$$-\frac{d\phi}{dt} = -M\frac{di}{dt}$$

But $-\frac{d\phi}{dt} = e$, where e is the induced emf in one when the magnetic flux is changing in the other.

$$\therefore e = -M\frac{di}{dt}.$$

If $\frac{di}{dt} = 1$, then $e = -M$.

The mutual inductance of two circuits is numerically equal to the induced e.m.f in one circuit due to unit rate of change of current in the other.

<u>Self inductance</u>: When a current flows through a coil it sets up a magnetic flux through it. The flux is proportional to current when the permeability of the medium remains constant.

$$\therefore \phi \propto i$$

$$\text{or} \quad \phi = Li \quad \text{—} \quad (2)$$

where L is a constant and is known as self inductance of the circuit. If $i = 1$, then $\phi = L$.

The self inductance is thus defined as the magnetic flux linked with a circuit when a unit current flows through it.

Differentiating eq^n (2) we have

$$-\frac{d\phi}{dt} = -L\frac{di}{dt} \quad \text{or} \quad e = -L \cdot \frac{di}{dt}$$

If $\frac{di}{dt} = -1$, then $L = -e$. The self inductance is thus numerically equal to the induced e.m.f in the circuit due to unit rate of change of current in it.