

Chapter 1

Electromagnetic induction

Faraday's laws may be stated as follows:

Law 1: Whenever there is a change in the magnetic flux linkage in a circuit, a voltage is induced in it.

Law 2: The magnitude of the emf induced is directly proportional to the rate of change of flux linkage.

If a flux ϕ links with a coil of N turns, the induced voltage in the coil is given by

$$e \propto \frac{d(N\phi)}{dt}$$

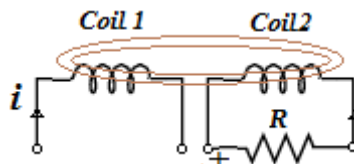
In SI system proportionality constant is 1. Hence,

$$e = N \frac{d\phi}{dt}$$

Lenz's law states that when an emf is induced by a change in magnetic flux, the polarity of the induced emf is such, that it produces an current that's magnetic field opposes the change which produces it. Combining Lenz's law with Faraday's law we can write:

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

where ϕ is the flux linking the coil and N is number of turns of the coil.



Consider two coils placed side by side. The first coil carries a current i which produces a flux that links the second coil. The voltage induced in the second coil should have such polarity that when a load is connected across its terminals, the load current flows in such a direction that it produces a flux opposing the flux produced by coil 1. Hence the polarity of left terminal of coil 2 should be positive.

Fleming's right hand rule Hold the thumb, the first and the second finger of the right hand at the right angles to each other. If the thumb points to the direction of motion and the first finger points to the direction of field, the second finger will point to the direction of induced current.

Fleming's left hand rule Hold the thumb, the first and the second finger of the left hand at the right angles to each other. If the first finger points to the direction of field and the second finger points to the direction of current, the thumb will point to the direction of force or motion.

According to Faraday's laws, a voltage is induced in a coil due to change in flux-linkage. If this change is due to the time varying current flowing into the coil itself (**self induced voltage**) or current flowing into another coil (**mutually induced voltage**) placed close to it, the induced voltage is called the **statically induced voltage**.

When there is a relative motion between a coil and a magnetic field, the coil experiences a change in flux-linkage, a voltage is induced in the coil. This voltage is called **dynamically induced voltage** or generated voltage.