Electromagnetic Induction

An emf induced in a ckt by changing flux.

Faraday's laws

① First law: Whenever a change in flux there will be an induced emf.

② Second law: This induced emf $\propto$ rate of change of flux linkage.

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

$$\propto N \frac{d\phi}{dt}$$

$\phi_1 \to \phi_2$ in t s

$$e = N\,\frac{(\phi_2 - \phi_1)}{t}$$

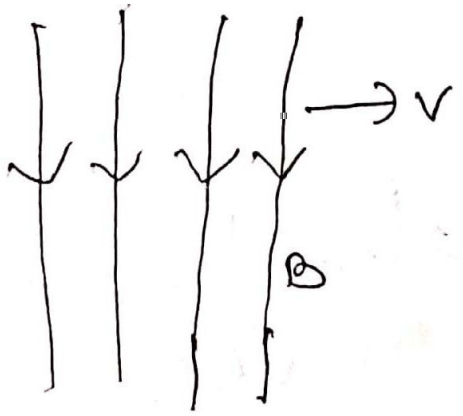
Lenz's law

Direction of induced emf so as to oppose the change in flux.

$$\mathcal{E} = -N \frac{d\phi}{dt}$$

1. Statically induced emf
   * Conductor remains stationary
   * Transformer

2. Dynamically induced emf.
   * relative motion of conductor
   * Generator



$\mathcal{E} = BlV\sin\theta$

$\theta = 90°$

$\mathcal{E} = BlV$

@ Flemings Right Hand Rule

Thumb : direction of motion.

forefinger : " of field

Middlefinger : " of induced current.

* Statically Induced

1. Self Induced

Change in current/flux on the same coil

$e \propto \frac{di}{dt}$

$\mathcal{E} = L\frac{di}{dt}$

L - Self Inductance

$-L\frac{di}{dt} = -N\frac{d\phi}{dt}$

$L = N\frac{d\phi}{di}$

$L = \left(\frac{N\phi}{I}\right), L = \frac{N^2}{S}$

2. Mutualy induced.

$e_2 \propto \frac{d\phi_m}{dt}$

$e_2 \propto \frac{di_1}{dt}$

$e_2 = N_2\frac{d\phi_m}{dt}$

$e_2 = M\frac{di_1}{dt}$, M - Mutual Inductance

$M = N_2\frac{d\phi_m}{di_1} = N_2\frac{\phi_m}{I_1}$

$M = \frac{N_1 N_2}{S}$

Coefficient of Coupling

L_1, L_2, M $\quad \boxed{K = \frac{M}{\sqrt{L_1 L_2}}}$, $K_{max} = 1$

$M = \sqrt{L_1 L_2}$

? Find the induced emf in a conductor, when it is rotated in a uniform B, ϕ = 2mWb in 0.2 Sec. N = 100

$$\mathcal{E} = -N\frac{d\phi}{dt} = -100 \times \frac{2 \times 10^{-3}}{2 \times 10^{-2}} = 10$$

? A coil consists of 750 turns and I = 10 A in a coil produces $\phi = 1.2 mWb$. Calculate inductance. If the current in coil reversed in 0.06 Sec. Find average emf induced in coil.

$N = 750$
$i = 10\ A$.
$\phi = 1.2 \times 10^{-3}\ Wb$

$$L = -N\frac{d\phi}{di} = \frac{N\phi}{I}$$

$$= \frac{750 \times 1.2 \times 10^{-2}}{10} = 0.9\ H.$$

$$e = -L\frac{di}{dt} = 0.9 \times 10$$