



INTERMEDIATE

Electromagnetic Induction [E.M.I]

Hand Notes For JEE Mains, Advance, NEET UG, Class 11 & 12 etc...

Hand Notes

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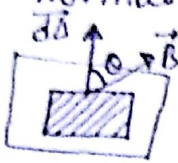
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ELECTROMAGNETIC INDUCTION [E.M.I.]

To produce induced current in the loop or, induced emf, there should be relative motion between coil & the magnets, so that the magnetic flux change w.r.t time.

Magnetic flux (ϕ)

It is no. of lines of force passing through a surface placed normal to magnetic field.



flux with small area element.

$$d\phi = B(dA \cos \theta)$$

$$d\phi = \vec{B} \cdot d\vec{A} \quad (\text{scalar quantity})$$

unit \rightarrow Wb, Tm² = MKS

Maxwell, (10⁸ cm²) = CGS

$$1 \text{ Wb} = 10^8 \text{ Maxwell}$$

Case-I \rightarrow If field is uniform & surface is plane.

$$\phi_{\text{net}} = \int B dA \cos \theta$$

$$= B \cos \theta \int dA$$

$$* \phi_{\text{net}} = B A \cos \theta$$

$$\phi_{\text{net}} = \vec{B} \cdot \vec{A}$$

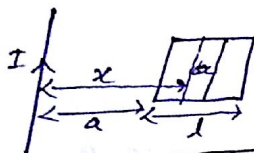
If no. of turn in the coil are 'n'

$$\phi = N B A \cos \theta$$

Case-II \rightarrow In case of non-uniform field.

$$* \phi_{\text{net}} = \int \vec{B} \cdot d\vec{A}$$

A square of side 'l' is placed in same plane with a long wire as shown fig. then flux with loop.



$$\phi_{\text{net}} = \frac{\mu_0 I l}{2\pi} \log_e \left[\frac{a+l}{a} \right]$$

##

$$\phi = N B A \cos \theta$$

$$\phi = f(B, A, \theta)$$

\rightarrow If $\phi \Rightarrow \text{const} \Rightarrow \text{NO EMI.}$
 \rightarrow If $\phi \Rightarrow \text{non-const} \Rightarrow \text{EMI.}$

|| \rightarrow $A \perp B \Rightarrow \phi = 0$

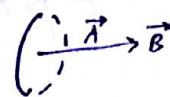
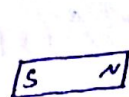
|| \rightarrow $\phi = 0$

|iii| →



$B_{\text{wire}} \perp A_{\text{coil}}$
 $\Rightarrow \phi = 0$

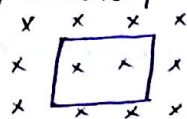
|iv| →



$\phi \neq 0$ but const

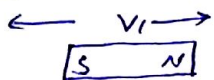
$\Rightarrow \frac{d\phi}{dt} = 0 \Rightarrow \text{NO EMI}$

|v| → If a coil placed in uniform transverse magnetic field.



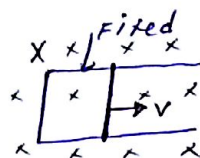
$\phi \neq 0$
 but const.
 NO EMI

|vi| →



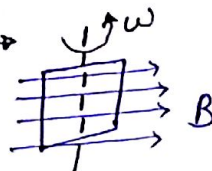
$\Rightarrow B \neq \text{const}$
 $\phi \neq \text{const}, \text{EMI}(\checkmark)$

|vii| →



$A \neq \text{const}$
 $\phi = \text{const}$
 EMI(\checkmark)

|viii| →



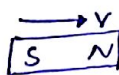
$\phi \neq \text{const}$
 $\theta \neq \text{const}$
 EMI(\checkmark)

|ix| →



$\phi \neq 0$
 $\phi = \text{const}$
 NO EMI

|x| →



$\phi \neq 0$
 $\phi = \text{const}$
 NO EMI.

Faraday's Law of EMI

on the basis of his observation, Faraday given, a mathematical form of b/w the changing flux & Induced emf.
 "Induced emf in a closed loop is always equal to Rate of change of flux w.r.t time"

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

If loop contains 'N' turns.

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

$\phi = \text{Magnetic flux}$

$e = \text{Induced emf in closed loop}$

NOTE * \ominus ve sign indicates that change in flux always opposes the induced emf generated in the loop.

* $\phi = B A \cos \theta$ It can be changed with the variation of B, A & θ .

* Induction takes place till the flux keep on changing.

$$|e| \propto \frac{d\phi}{dt}$$