UNIT- III

FARADAY'S LAW →

$$emf = -\frac{d\phi}{dt}\ V$$

A time-varying magnetic field produces an electromotive force (emf) which may establish a current in a suitable closed circuit. An emf is merely a voltage that aries from conductors moving in a magnetic field or from changing magnetic fields.

Faraday's law is customarily stated as,

$$emf = -\frac{d\phi}{dt}\ V \qquad \text{—(1)}$$

A nonzero value of $\frac{d\phi}{dt}$ may result from any of the following situations:

1. A time-varying flux linking a stationary closed path,
2. Relative motion between a steady flux and a closed path
3. A combination of the two

If the closed path is that taken by an N-turn filamentary conductor, it is often as-

$$emf = -N\frac{d\phi}{dt} \qquad \text{—(2)}$$

ϕ = flux

$$emf = \oint E \cdot dL \qquad -③$$

In electrostatics, the line integral leads to a potential difference, with time-varying fields, the result is an emf or a voltage.

Replacing ϕ in ① by the surface integral of B, we have

$$emf = \oint E \cdot dL = -\frac{d}{dt}\int_S B \cdot dS \qquad -④$$

B = flux density

We consider a stationary path. The magnetic flux is the only time-varying quantity on the right side of ④ & a partial derivative may be taken under the integral sign,

$$emf = \oint E \cdot dL = -\int_S \frac{\partial B}{\partial t} \cdot dS \qquad -⑤$$

Before we apply this simple result to an example,

Integral Form →

$$\boxed{\int_S (\nabla \times E) \cdot dS = -\int_S \frac{\partial B}{\partial t} \cdot dS}$$

where the surface integrals may be taken over identical surfaces,

Differential form →

$$(\nabla \times E) \cdot dS = -\frac{\partial B}{\partial t} \cdot dS$$

and

$$\boxed{\nabla \times E = -\frac{\partial B}{\partial t}}$$

DISPLACEMENT CURRENT →

By Faraday's law, We use one of of Maxwell's equations in differential form,

$$\nabla \times E = -\frac{\partial B}{\partial t} \quad \text{—(1)}$$

Now, point form of Ampere's circuital law as it applies to steady magnetic fields,

$$\nabla \times H = J \quad \text{—(2)}$$

By taking the divergence of each side,

$$\nabla \cdot \nabla \times H = 0 = \nabla \cdot J \quad \text{—(3)}$$