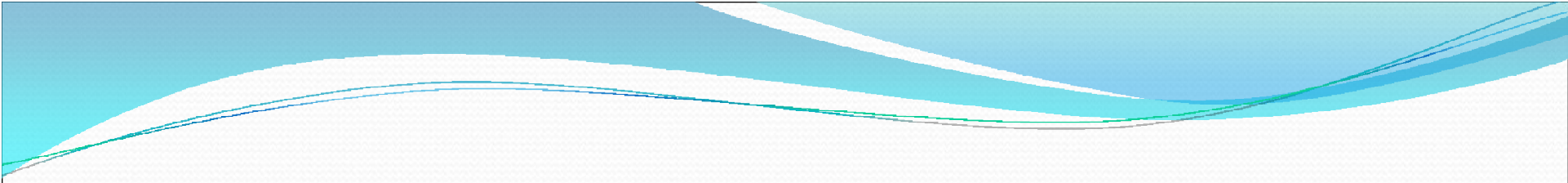


# LECTURE NO 29

# Topics

- Waves and applications:
- Maxwell's equation,
- Faraday's Law,
- transformer and motional electromotive forces

- 
- Faraday discovered that the **induced emf** (in volts), in any closed **circuit** is equal to the time rate of change of the magnetic flux linkage by the circuit.

$$V_{\text{emf}} = -\frac{d\psi}{dt}$$

$$V_{\text{emf}} = \oint_L \mathbf{E} \cdot d\mathbf{l} = -\frac{d}{dt} \int_S \mathbf{B} \cdot d\mathbf{S}$$

## B. Moving Loop in Static $\mathbf{B}$ Field (Motional emf)

When a conducting loop is moving in a static  $\mathbf{B}$  field, an emf is induced in the loop. We recall from eq. (8.2) that the force on a charge moving with uniform velocity  $\mathbf{u}$  in a magnetic field  $\mathbf{B}$  is

$$\mathbf{F}_m = Q\mathbf{u} \times \mathbf{B} \quad (8.2)$$

We define the *motional electric field*  $\mathbf{E}_m$  as

$$\mathbf{E}_m = \frac{\mathbf{F}_m}{Q} = \mathbf{u} \times \mathbf{B} \quad (9.9)$$

If we consider a conducting loop, moving with uniform velocity  $\mathbf{u}$  as consisting of a large number of free electrons, the emf induced in the loop is

$$V_{\text{emf}} = \oint_L \mathbf{E}_m \cdot d\mathbf{l} = \oint_L (\mathbf{u} \times \mathbf{B}) \cdot d\mathbf{l} \quad (9.10)$$