ELECTROMAGNETIC THEORY

- Electro magnetic Theory covers the basic principles, of electro magnetism: experimental basis, electrostatics, magnetic fields of steady currents, motional e.m.f and electromagnetic induction, Maxwell’s equations, propagation and radiation of electromagnetic waves, electric and magnetic properties of matter and conservation laws.

Why electromagnetic theory is needed?

- EM Theory is an essential basis for understanding the devices,methods and systems used for electrical energy both electric and magnetic fields are defined in terms of the forces they produce.

Who created electromagnetic waves?

- Heinrich Rudolf Hertz was a German Physicist who first conclusively proved the existence of the electromagentic waves theorized by James clerk maxwell's electromagnetic theory of light.

How was electromagnetic radiation discovered?

- In 1887 Heinrich Hertz demonstrated the existence of the waves predicted by maxwell by producing radio waves in his laboratory. It look a bit longer for scientists to discover the high energy light in the electromagnetic spectrum.

GAUSS'S LAW

- It states that , the divergence of the electric field intensity at any point is equal to $1/\varepsilon_0$ times the volume charge density at the points .

$$\nabla . \mathbf{E} = \rho / \varepsilon_0$$

APPLICATION OF GUASS LAW:

- Guass law is useful in calculating the electric field for a given charge distribution only for cases involving a high degree of symmetry since the unknown quantity E appears in the integrand.

ENERGY OF A CONTINUOUS CHARGE DISTRIBUTION

- Work done on a continuous charge distribution $= 1/2\int \rho V \, d\tau$
- The quantity $\frac{1}{2} \varepsilon_0 E^2$ is the energy density in the electric field.

GUASS LAW IN THE PRESENCE OF DIELECTRICS

- The flux of the electric displacement vector across an arbitrary closed surface is equal to the free charge enclosed by the surface.
- $\nabla . \mathbf{D} = \rho$

BIOT-SAVART LAW

- The force between two current elements dl1 and dl2 carrying steady current I1 and I2 respectively.
- It varies directly as the product of the magnitudes of currents.
- Varies inversely as the square of the distance between the two elements.
- **$B = \mu 0/4\pi \int I.dl/r^2$**

AMPERE'S LAW

- It states that the line integral of magnetic induction vector B around a closed path is equal to μ_0 times the total current crossing any surface bounded by the line integral path.
- $\int \mathbf{B.dl} = \mu_0 \mathbf{I}$

FARADAY'S LAW

- Faraday's law states that the absolute value or the magnitude of the circulation of the electric field E around a closed loop is equal to the rate of change of the magnetic flux through the area enclosed by the loop.

$$\nabla \times E = -\partial B / \partial t$$

MAXWELL'S EQUATION

- There are four fundamental equations of electromagnetism known as Maxwell's equations. These equations correspond to a generalisation of certain experimental observations regarding electricity and magnetism.
- $\nabla . \mathbf{D} = \rho$
- $\nabla . \mathbf{B} = 0$
- $\nabla \times \mathbf{E} = -\partial \mathbf{B} / \partial t$
- $\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D} / \partial t$

- Maxwell's equations are a set of four differential equations that form the theoretical basis for describing classical electromagnetism.
- Gauss's law:- Electric charges produce an electric field. The electric flux across a closed surface is proportional to the charge enclosed.
- Gauss's law for magnetism:- There are no magnetic monopoles. The magnetic flux across a closed surface is zero.
- Faraday's law:- Time varying magnetic fields produce an electric field.
- Ampere's law:- Steady currents and time varying electric fields produce a magnetic fields.

BOUNDARY CONDITIONS ON E,B,D,H

- The fields E,B,D,H will be discontinuous at a boundary between two different media or at a surface which carries charge density σ or current density K .
- $D1_{\perp} - D2_{\perp} = \sigma$
- $B1_{\perp} - B2_{\perp} = 0$
- $E1_{||} - E2_{||} = 0$
- $H1_{||} - H2_{||} = K$

SCALAR AND VECTOR POTENTIALS

- $B = \nabla \times A$
- $E = -\nabla V - \partial A / \partial t$
- Where A is called the vector potential , V is called the scalar potential.
- They are mathematical functions which are not physically measurable.
- They are not independent of each other .
- These define the field vectors E and B uniquely, though they themselves are non-unique.
- They play an important role in relativistic electrodynamics.

ENERGY IN ELECTRODYNAMICS

- $dw/dt = -\int 1/2\ (\varepsilon_0 \mathbf{E}_2 + 1/\mu_0\ \mathbf{B}^2)\ d\tau - 1/\mu_0 \int (E \times B)\ da$

- The first integral of the equation is the total energy stored in the field W_{EB}.
- The second term represents the rate at which energy is carried out of V across its boundary surface by the electromagnetic field

Thank You