MADE EASY
ELECTRONICS ENGINEERING
E.M.T
By- V.S.R Suresh Sir

SYLLABUS :-

	THEORY	PROBLEMS	PROBLEMS
1) Static Electromagnetic Fields.	(Hayt and Buck);	Sadiku ;	Schaum Series

2) Time varying fields → Electro-Magnetic waves. (JORDAN BALMAIN).
3) Transmission Lines → Voltage and current waves. (JOHN D RYDER).
4) Waveguides (JORDAN BALMAIN).
5) Antennas and Radiated waves. (JORDAN BALMAIN).

Methodology of Preperation :-

VSRS22@gmail.com
facebook ID
VSR suresh.

1) Concepts / Theory / Fundamentals.
2) Application / Questioning style.
3) Beyond classroom
   ↳ Previous Papers → EC (Gate / ESE).
   → EE (Gate / ESE).

TEXT BOOK :-

1) HAYT & BUCK.
2) SADIKU.
3) JOHN D RYDER.
4) JORDAN BALMAIN.

SESSION 1 :-

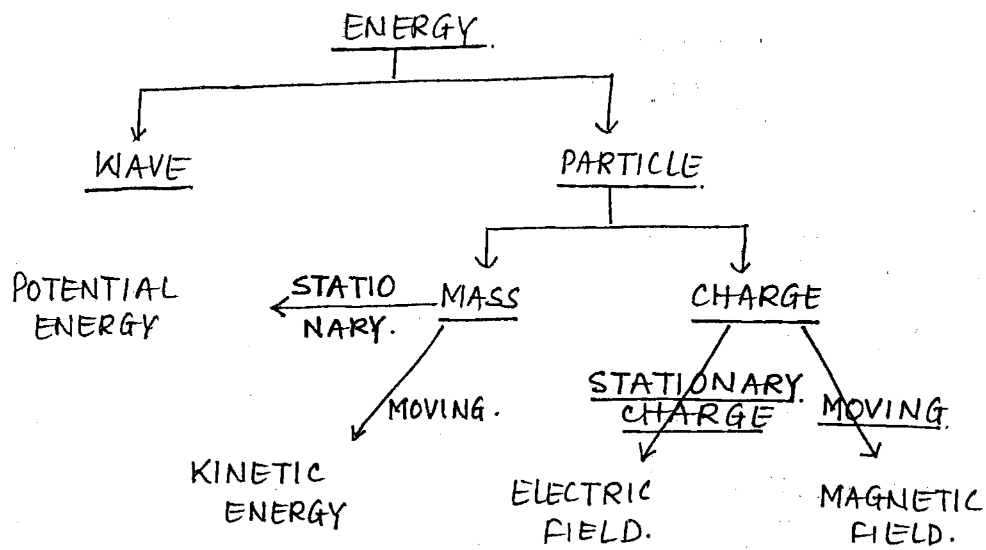
1. Vector calculus.
   * Vector function
   * Density / Intensity funcn
2. Co-ordinate Systems
   * dl, ds, dv
   * (·) Dot
   * (x) Cross.

STATIC ELECTRO-MAGNETIC FIELDS

SESSION 1

*DEFINITION OF FIELD:-

* Everything in this world is ENERGY.



ELECTRIC FIELD:-

* Electric field is a format of Energy that is all around a charge and influences similar charges nearby

Note:- Electric field cannot be seen but can be felt by a test charge when brought in its vicinity.

MAGNETIC FIELD:-

* Magnetic field is a format of Energy that is all around a moving charge and influences similar moving charges nearby

Note:- Magnetic field cannot be seen but can be felt by another moving charge.

Note:-

1) Stationary charge → (CAUSE) VOLTAGE (D.C voltage)
↓
ELECTRIC FIELD (EFFECT)

Note:-

* When voltages are given to the conductors, materials then the effect is seen in the free space.

Note:- As in Antennas, where Voltages and currents are given to the conductors and they start radiating signals in 3D space

* Voltages to conductors, materials (2D).
  ↳ effects the outer space (free space) (3D).

2) Moving charge $\longrightarrow$ DC CURRENT
$\downarrow$
CAUSE
$\downarrow$
MAGNETIC FIELD.
(EFFECT)

Note:-

* when current is given to the conductor, materials it will give the cause in the free space and that is 3D space.
* Current or Voltage given to Antenna hence felt in free space.

VECTOR CALCULUS:-

* It is the study of DIRECTIONAL INTEGRATIONS and DIRECTIONAL DERIVATIVES in 3 DIMENSIONAL SPACE.

DIRECTIONAL INTEGRATION:-

* It is calculation of the total effect of any phenomenon in a given direction in a given region.
* This can be implemented over a line, over a surface or over a volume. ie

$\int dl \longrightarrow$ line Integral.

$\iint ds \longrightarrow$ Surface Integral.

$\iiint dv \longrightarrow$ volume Integral.

DIRECTIONAL DERIVATIVE:-

* Directional derivative is the study of RATE OF CHANGE of any phenomenon in a given direction in a given region.
* Helps in the study of Rate of flow.
* Helps in understanding the nature of variation of any phenomenon.
* DEL OPERATOR is used for study of spatial variations in 3D of space. It is a vector operator.

Mathematically,

$$\boxed{\nabla = \frac{\partial}{\partial x} a_x + \frac{\partial}{\partial y} a_y + \frac{\partial}{\partial z} a_z}$$ $\leftarrow$ derivation along with the directions.

** It can be used to study the Rate of change of:

1) Scalar Quantities.
2) Vector Quantities.

* Examples are:

1) $f(x,y,z) = 4x^2y - 5z^3$ ← Scalar Quantity.

2) $\bar{A}(x,y,z)(x,y,z) = 4x^2y\,a_x + 7y\,a_y + 12xz\,a_z$ ← Vector Quantity.

Mag. depends on (X, Y, Z)   direction depends on (X, Y, Z)

3) $A(x)y = 4x^2 a_y$ ← mag. depends on x. direction depends on y.

* GRADIENT:

* $\nabla \rightarrow$ operated on scalar function ie ∇f

** $\boxed{\text{Gradient of scalar} \rightarrow \text{Result is vector function}}$

* DIVERGENCE AND CURL:

* ∇ operated on Vector function is called as:

1) Divergence → Dot product
2) Curl → Cross Product.

* Divergence of Vector given as $\nabla\cdot\vec{A}$. The Result is a scalar.
* curl of Vector given as $\nabla\times\vec{A}$. The Result is vector.

Mathematically,

** 1) $\nabla\cdot\vec{A}$ = Dot product = Divergence of Vector
Result of operation is SCALAR.

** 2) $\nabla\times\vec{A}$ = cross product = curl of Vector
Result of operation is Vector.

Note :-

* $\boxed{\nabla \cdot \nabla = \nabla^2 = \text{Second order derivative}}$ ← called as SCALAR LAPLACIAN operator.

Vector Identity :-

1) $\boxed{\nabla \times \nabla f = \nabla \times (\nabla f) = 0}$

$\boxed{\text{curl of Gradient of Scalar} = 0}$

2) $\boxed{\nabla \cdot (\nabla \times A) = 0}$

$\boxed{\text{Divergence of curl of Vector} = 0}$

Note :-

$A \times B = C$

$C \perp (A \ \& \ B)$

Hence, $A \times C = |A||C| \sin 90^\circ \hat{n}$

$= |A||C| \hat{n}$

$A \cdot C = AC \cos 90^\circ$

$= 0.$

So, $\boxed{A \cdot (A \times B) = 0 \Rightarrow \nabla \cdot (\nabla \times A) = 0.}$

Note :-

$A \times B = |A||B| \sin\theta \, \hat{n}$

$A \cdot B = |A||B| \cos\theta$

* $\nabla \times \nabla = 0$; Since both are same vectors and moving in same direction as like $A \times A$. Hence,

$\nabla \times \nabla = |\nabla||\nabla| \sin 0 \, \hat{n} = 0$

So, $(\nabla \times \nabla f) = 0$

* ~~Also, $\nabla \times \nabla \neq 0$; Since both are same vector and moving in same direction.~~

* $\nabla \times A$ results in a vector $\perp^r$ to both ∇ and A. Hence

$\nabla \cdot (\nabla \times A) = \nabla \cdot B$

$B = (\nabla \times A)$ and $B \perp A$

$B \perp \nabla$.

So, $\nabla \cdot B = |\nabla||B| \cos 90^\circ$

$= 0.$

3) $\boxed{\nabla \times (\nabla \times A) = \nabla(\nabla \cdot A) - \nabla^2 A}$

Note :-

1. $\nabla \times (\nabla \cdot A)$
2. $\nabla (\nabla \times A)$

} → not allowed. { Since curl of Scalar is not allowed. Also, ~~Divergence~~ Gradient of Vector is not allowed.

3. $\nabla (\nabla \cdot A) = \nabla^2 A$

*OUTFLOW & DIVERGENCE OF VECTOR FUNCTION :-

*Consider a cause or a source, having some effects radially outward from the cause. For all such phenomenon the STRENGTH decreases as the AREA OF EXPANSION increases; such that :-

"The TOTAL OUTFLOW, through any enclosing surface is always a CONSTANT, and this constant depends on the central cause"

*The strength represents a DENSITY VECTOR FUNCTION or closeness of the lines; and mathematically

$$\boxed{\text{strength} = \frac{\text{Constant}}{\text{Area}} = \frac{\text{cause}}{\text{Area}}} \qquad \boxed{\text{Constant} \propto \text{Cause}}$$

*If a cause is of Q coulombs of charge, the effect represents, the Physical attractive or repulsive force on any charge nearby. This is called as Electric flux or electric field.

CAUSE OR SOURCE : Q

EFFECT : Electric Force/Field/Flux (Ψ_e)

STRENTH OF EFFECT :- Electric flux Density ($\vec{D}$)

*The strength is ~~cause~~ called as Electric flux Density ($\vec{D}$) such that :-

$$\boxed{\oiint_{\text{closed}} \vec{D}\cdot\vec{ds} = \Psi_{e\,(\text{total})} \propto Q.}$$

Note :- The effect around the charge (Q) is called as Electric field and can be felt by test charge and is not visible.

$$\boxed{\oiint_{\text{closed}} \vec{D}\cdot\vec{ds} = Q.} \leftarrow \text{GAUSS LAW IN INTEGRAL FORM.}$$

Note :-

*If the surface is not completely enclosing, the effects are Partial

ie ~~$\oiint D\cdot ds$~~

$$\boxed{\iint_{\text{open}} D\cdot ds = \Psi_e \neq Q \leftarrow \text{flux Passing through the surface (open), only through that open surface and this is not GAUSS LAW.}}$$

* Every closed Surface is Identified with a finite volume enclosed.

1) $4\pi r^2 \xrightarrow{\text{sphere}} \frac{4}{3}\pi r^3$

2) $2\pi r h \xrightarrow{\text{cylinder}} \pi r^2 h$

3) $6a^2 \xrightarrow{\text{cube}} a^3$

4) $\pi r^2 \xrightarrow{\text{circle}}$ volume not defined.

* Mathematically,

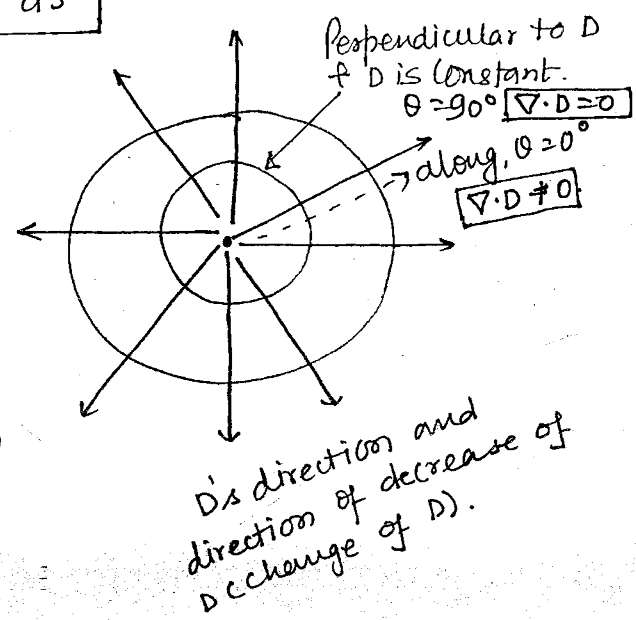
$$\boxed{\text{strength of field, } \vec{D} = \frac{dQ}{ds}} \leftarrow \text{coulombs}/m^2.$$

* $\frac{dQ}{dv} = \frac{d}{dl}\left(\frac{dQ}{ds}\right)$

so, $\frac{dQ}{dv} = \frac{d}{dl}\left(\frac{dQ}{ds}\right) = \nabla \cdot D$

$\rho_V = \nabla \cdot D$

so, $\boxed{\nabla \cdot D = \rho_V}$ ← GAUSS LAW in point form



Divergence at any point depends on the volume charge density

* The DOT (·) operation in derivative signifies the directional derivative in the vector direction.

Note:

* Rate of change of strength (D) ← ELECTRIC FLUX depends on charge density (ρ_V). ($\nabla \cdot D = \rho_V$)

* $\boxed{\nabla \cdot D = |\nabla||D|\cos\theta}$

* The significance of Dot product is that, to understand the Rate of change of D, we have to read it along D. The surface given above are ⊥r to D. Hence $\theta = 90° \Rightarrow \nabla \cdot D = 0$

Note Cause: Q → Effect = D or E.

* ∇·D → Represents rate of change of effect
  * helps in understanding the cause.
  * by finding ρ_V, charge stored in the volume helps in understanding the charge, Q.