ENGINEERING PHYSICS-PHY 110

UNIT:1 ELECTROMAGNETIC THEORY

Lecture 1

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20/01/23 Lecture 0: Introduction to PHY110, Zero Lecture

31/01/23 Lecture 1: Scalar and Vector Fields, Concept of Gradient, Divergence and Curl

01/02/3 Lecture 2: Gauss theorem and Stokes theorem (qualitative); Gauss law of electrostatics, Poisson, Laplace Equations, Continuity Equation

03/02/23 Lecture 3 Gauss law of magnetostatics, Faraday's law of electromagnetic induction, Ampere Circuital law, Maxwell's displacement current and corrections in Ampere Circuital Law

07/02/23 Lecture 4: Electric field, Displacement current, dielectric constant, Magnetic field and magnetic field strength, Maxwell's equation..

08/02/23 Lecture 5 Maxwell's Electromagnetic Equations (Differential and integral forms)

10/02/23 Lecture 6 Electromagnetic waves, Physical significance of Maxwell Equations, electromagnetic spectrum

14/08/23 Lecture 7: Application of 'EM' theory in resistive touch screen display, capacitive touchscreen display, Imaging devices

Quick QUIZ on 20th Jan 2022

No	Question	Attempts	Right	Wrong
1	How many UNITS will be covered in PHY109 Engineering Physics?			
2	Identify the devices that do not use electromagnetic energy			
3	Why are lasers used in “Laser Printers”			
4	A dielectric waveguide for the propagation of electromagnetic energy at light frequencies			
5	A black body appears black because it..			
6	Solids with high value of conductivity are called:			

How many UNITS will be covered in PHY109 Engineering Physics?

a) 3
b) 4
c) 5
d) 6

Identify the devices that do not use electromagnetic energy.

a) Television

b) Washing machine

c) Microwave oven

d) Mobile phones

Why are lasers used in "Laser Printers"

(a) They can be focused down to very small spot sizes for high resolution

(b) They are cheap

(c) They are impossible to damage

(d) Easy to refill

A dielectric waveguide for the propagation of electromagnetic energy at light frequencies

a. Stripline
b. Microstrip
c. Laser beam
d. Optical fiber

A black body appears black because it..

a) Does not reflect light
b) Does not transmit light
c) Does absorb light
d) **All of the above**

What is the most fundamental property of wave?

a) Temperature
b) Pressure
c) Frequency
d) Wavelength

Solids with high value of conductivity are called:

(a) Metals
(b)Nonmetal
(c)Insulator
(d)Semi conductor

PHYSICAL QUANTITIES

Physical Quantity: Any quantity that can be measured/determined and has a magnitude and unit.

Examples: Mass, weight, distance, length displacement, speed, velocity, pressure, temperature, force, acceleration, energy, current ..etc..

Scalar

- Physical quantity that has only magnitude and has no direction

Vector

- Physical quantity that has magnitude and also has direction

Do you know about TENSOR?

If a tensor has only magnitude and no direction (i.e., rank 0 tensor), then it is called scalar.

If a tensor has magnitude and one direction (i.e., rank 1 tensor), then it is called vector.

Tensor of Rank 2 is called matrix.

SCALARS AND VECTORS

Scalar quantity

- It is <u>enough</u> to know its magnitude (numerical value and unit to express it)

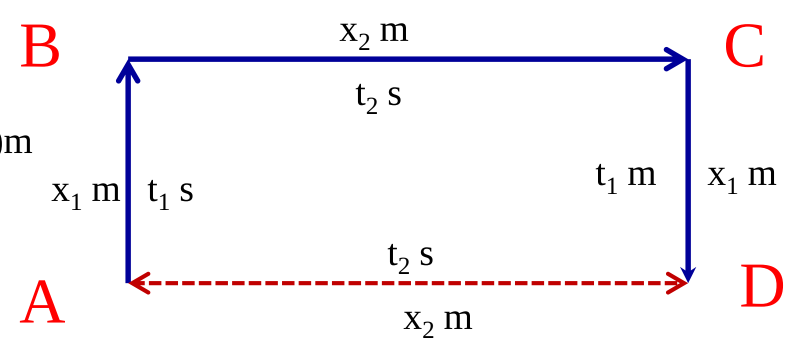
Examples:. Mass (kg), length (m), distance (m), Current (A), time (s), <u>speed (m/s),</u> temperature (°C), Energy (J)

Vector Quantity

- It is <u>necessary</u> to know its magnitude (numerical value and unit) and also the direction

Examples: Displacement (m), <u>velocity (m/s),</u> acceleration (m/s^2), force (N), Weight (N)

Distance=AB+BC+CD=$(2x_1+x_2)$m
Speed = $(2x_1+x_2)/(2t_1+t_2)$ m/s



Displacement= AD=x_2 m
Velocity= $x_2/(2t_1+t_2)$ m/s

The quantity which has only magnitude is called?

a) A scalar quantity
b) A vector quantity
c) A chemical quantity
d) A magnitude quantity

Force is a vector quantity. True or false?

a) True
b) False

The quantity which has magnitude and direction is called?

a) A scalar quantity
b) A vector quantity
c) A chemical quantity
d) A magnitude quantity

Vector Basics

- We will be using vectors a lot in this course.
- Remember that vectors have both magnitude and direction e.g. $a,\ \theta$
- You should know how to find the components of a vector from its magnitude and direction

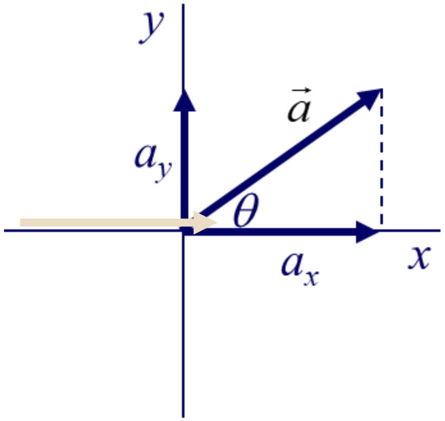
$$a_x = a\cos\theta$$
$$a_y = a\sin\theta$$

- You should know how to find a vector's magnitude and direction from its components

$$a = \sqrt{a_x^2 + a_y^2}$$
$$\theta = \tan^{-1} a_y / a_x$$

Ways of writing vector notation

$$\mathbf{F} = m\mathbf{a}$$
$$\vec{F} = m\vec{a}$$
$$\underline{F} = m\underline{a}$$



VECTOR ALGEBRA

Algebraic operation on Vectors

1. **Addition**
2. **Subtraction**
3. **Products**
    1. **Dot product**
    2. **Cross product**

Properties of Vector addition

1. **Commutative property: For any two vectors** $\vec{a}$ and $\vec{b}$

$$\vec{a} + \vec{b} = \vec{b} + \vec{a}$$

2. **Associative property: For any three vectors** $\vec{a}, \vec{b}$ and $\vec{c}$

$$\left(\vec{a} + \vec{b}\right) + \vec{c} = \vec{a} + (\vec{b} + \vec{c})$$

The associative property of vector addition enables us to write the sum of three vectors without using brackets

VECTORS ALGEBRA

- Null vector $\vec{0}$
  Additive identity, $\vec{a} + \vec{0} = \vec{0} + \vec{a} = \vec{a}$
- Unit vector $\dfrac{\vec{a}}{|a|} = \hat{a}$

Multiplication of a Vector by a Scalar

Let $\vec{a}$ is vector and λ is scalar, then $\lambda\vec{a}$ is the multiplication of vector $\vec{a}$ with scalar λ.

in Fig 10.12.

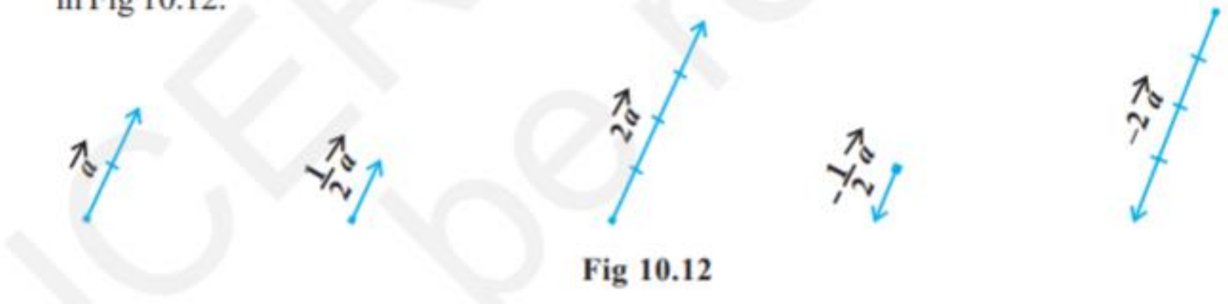


Fig 10.12

Magnitude of the null vector is

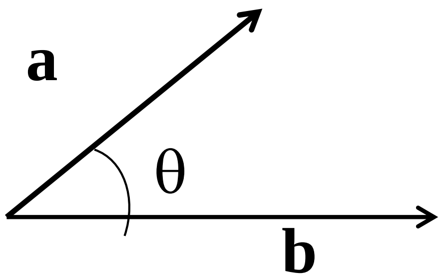
a) 1
b) 0
c) -1
d) ∞

Magnitude of the unit vector is

a) 1
b) 0
c) -1
d) ∞

VECTORS ALGEBRA: Dot product of two vectors

Vectors **a** and **b** with an θ between them



$$\mathbf{A} \bullet \mathbf{B} = AB\cos\theta$$

- Dot product of two vectors is a scalar
- Why cos θ?

This the case if we know the magnitude of two vectors and the angle between them.. What if know only the components along X,Y and Z direction?

Derivation; Dot product of two vectors

- How do we show that $\vec{A}\cdot\vec{B} = A_x B_x + A_y B_y + A_z B_z$
- Start with $\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

  $\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$
- Then

$$\vec{A}\cdot\vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$
$$= A_x\hat{i}\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k}) + A_y\hat{j}\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k}) + A_z\hat{k}\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$

- But

$$\hat{i}\cdot\hat{j} = 0;\ \hat{i}\cdot\hat{k} = 0;\ \hat{j}\cdot\hat{k} = 0$$
$$\hat{i}\cdot\hat{i} = 1;\ \hat{j}\cdot\hat{j} = 1;\ \hat{k}\cdot\hat{k} = 1$$

- So

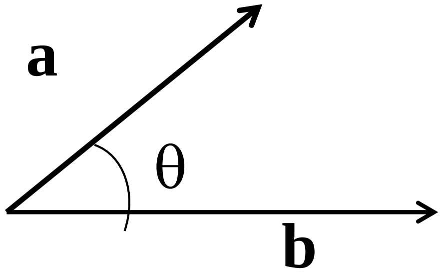
$$\vec{A}\cdot\vec{B} = A_x\hat{i}\cdot B_x\hat{i} + A_y\hat{j}\cdot B_y\hat{j} + A_z\hat{k}\cdot B_z\hat{k}$$
$$= A_x B_x + A_y B_y + A_z B_z$$

Dot product of two identical vectors (**A**) is a

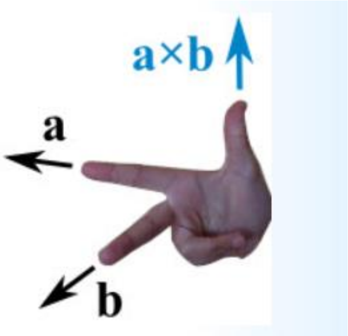
a) Zero
b) A^2

VECTORS ALGEBRA: Cross product of two vectors

Vectors **a** and **b** with an θ between them



$$\mathbf{a} \times \mathbf{b} = ab \sin\theta$$



- ➢Cross product of two vectors is vector
- ➢Lies perpendicular to the both **a** and **b**

This the case if we know the magnitude of two vectors and the angle between them.. What if know only the components along X,Y and Z direction?

Derivation

- How do we show that $\vec{A}\times\vec{B}=(A_yB_z-A_zB_y)\hat{i}+(A_zB_x-A_xB_z)\hat{j}+(A_xB_y-A_yB_x)\hat{k}$?
- Start with $$\vec{A}=A_x\hat{i}+A_y\hat{j}+A_z\hat{k}$$ $$\vec{B}=B_x\hat{i}+B_y\hat{j}+B_z\hat{k}$$
- Then $$\vec{A}\times\vec{B}=(A_x\hat{i}+A_y\hat{j}+A_z\hat{k})\times(B_x\hat{i}+B_y\hat{j}+B_z\hat{k})$$ $$=A_x\hat{i}\times(B_x\hat{i}+B_y\hat{j}+B_z\hat{k})+A_y\hat{j}\times(B_x\hat{i}+B_y\hat{j}+B_z\hat{k})+A_z\hat{k}\times(B_x\hat{i}+B_y\hat{j}+B_z\hat{k})$$
- But $$\hat{i}\times\hat{j}=\hat{k};\ \hat{i}\times\hat{k}=-\hat{j};\ \hat{j}\times\hat{k}=\hat{i}$$ $$\hat{i}\times\hat{i}=0;\ \hat{j}\times\hat{j}=0;\ \hat{k}\times\hat{k}=0$$
- So $$\vec{A}\times\vec{B}=A_x\hat{i}\times B_y\hat{j}+A_x\hat{i}\times B_z\hat{k}+A_y\hat{j}\cdot B_x\hat{i}+A_y\hat{j}\cdot B_z\hat{k}$$ $$+A_z\hat{k}\cdot B_x\hat{i}+A_z\hat{k}\cdot B_y\hat{j}$$

Cross product of two identical vectors (**A**) is a

a) Zero
b) A^2

Cross product of two vectors is a

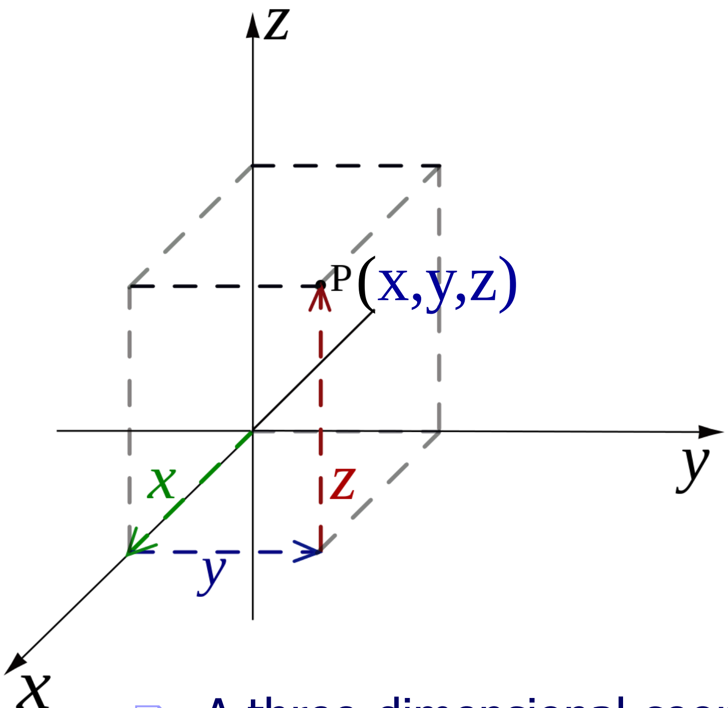
a) Vector quantity
b) Scalar quantity

Dot product of two vectors is a

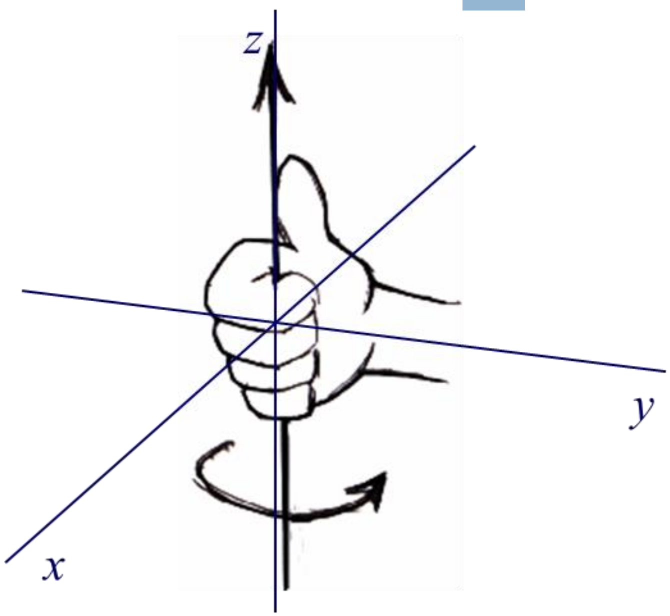
a) Vector quantity
b) Scalar quantity

RECTANGULAR CO-ORDINATE SYSTEM

Components of a vector, with **i, j, k** unit vectors



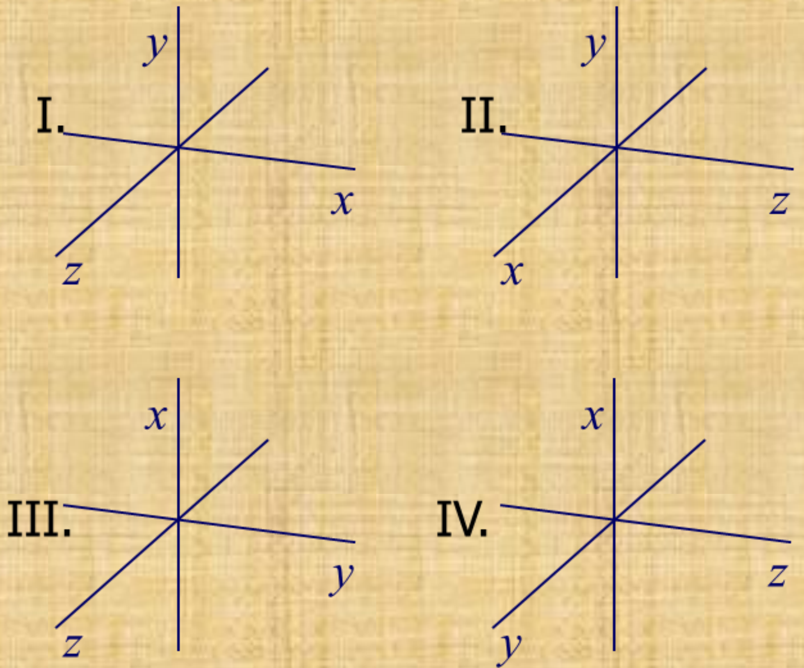
$$\vec{A} = (\hat{i}A_x + \hat{j}A_y + \hat{k}A_z)$$



- A three-dimensional coordinate system MUST obey the right-hand rule.
- Curl the fingers of your RIGHT HAND so they go from x to y. Your thumb will point in the z direction.

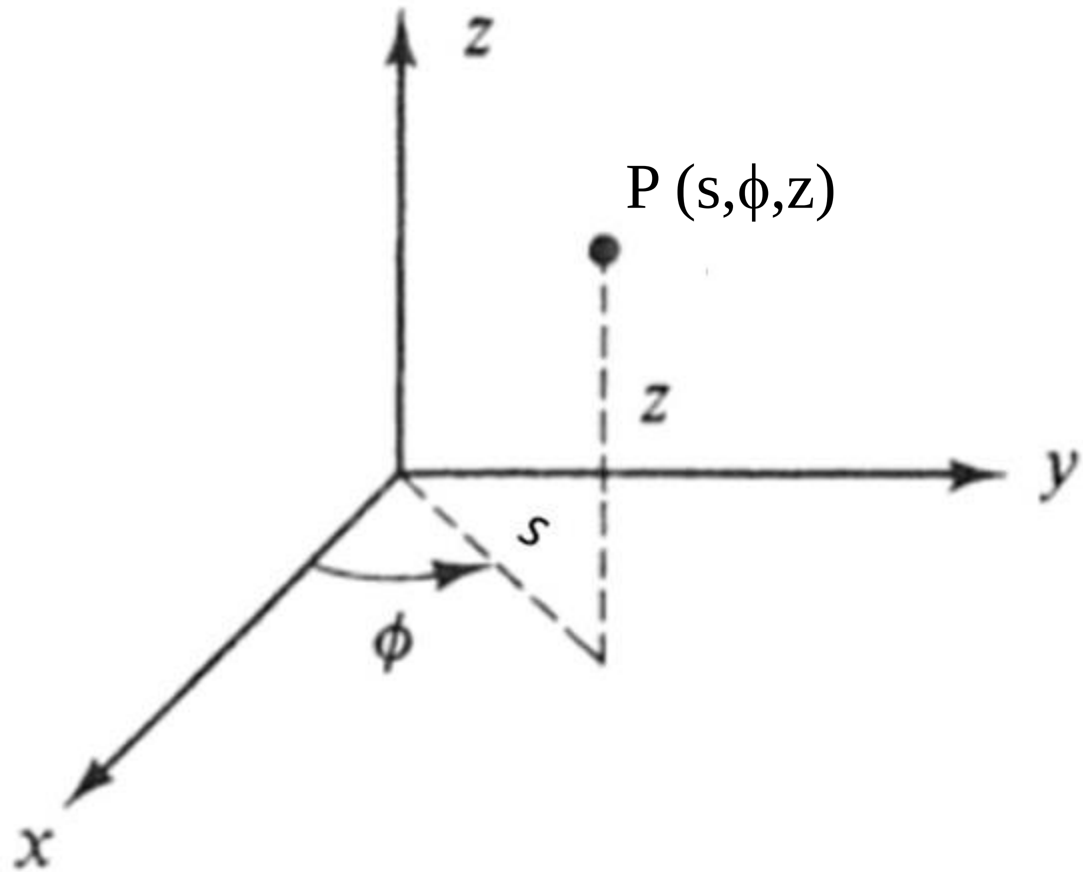
Right Handed Coordinate Systems

Which of these coordinate systems obey the right-hand rule?



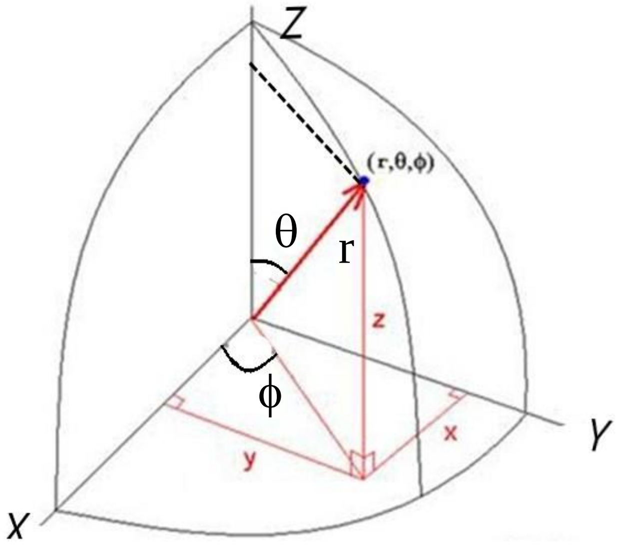
a) I and II.
b) II and III.
c) I, II, and III.
d) I and IV.
e) IV only.

CYLINDRICAL CO-ORDINATE SYSTEM



$x = s\cos\phi = \boldsymbol{f}\,(\mathbf{s},\boldsymbol{\phi})$
$y = s\sin\phi = \boldsymbol{f}\,(\mathbf{s},\boldsymbol{\phi})$
$z = z$

SPHERICAL POLAR CO-ORDINATE SYSTEM



r-projection = r Sinθ= ***f* (r,θ)**

x=r-projection. Cosϕ = r Sinθ Cosϕ= ***f* (r,θ,ϕ)**

y=r-projection.Sinϕ = r Sinθ Sinϕ= ***f* (r,θ,ϕ)**

z= r Cosθ= ***f* (r,θ)**

If the vector is a function (r,θ,ϕ), which co-ordinate system is used

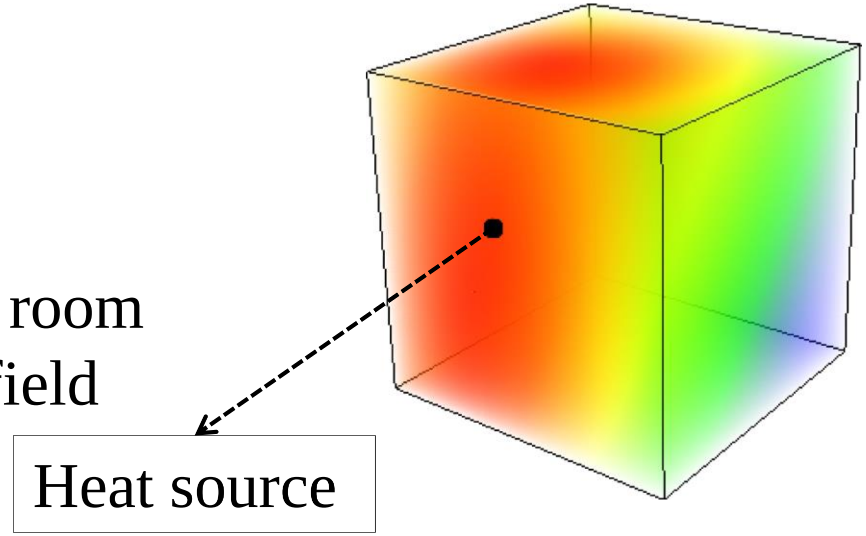
a) Rectangular
b) Cylindrical
c) Spherical

SCALAR FIELDS?

A field is a function that has a different value at every point in space

A **scalar** function defines a scalar **field** in that domain or on that surface or curve

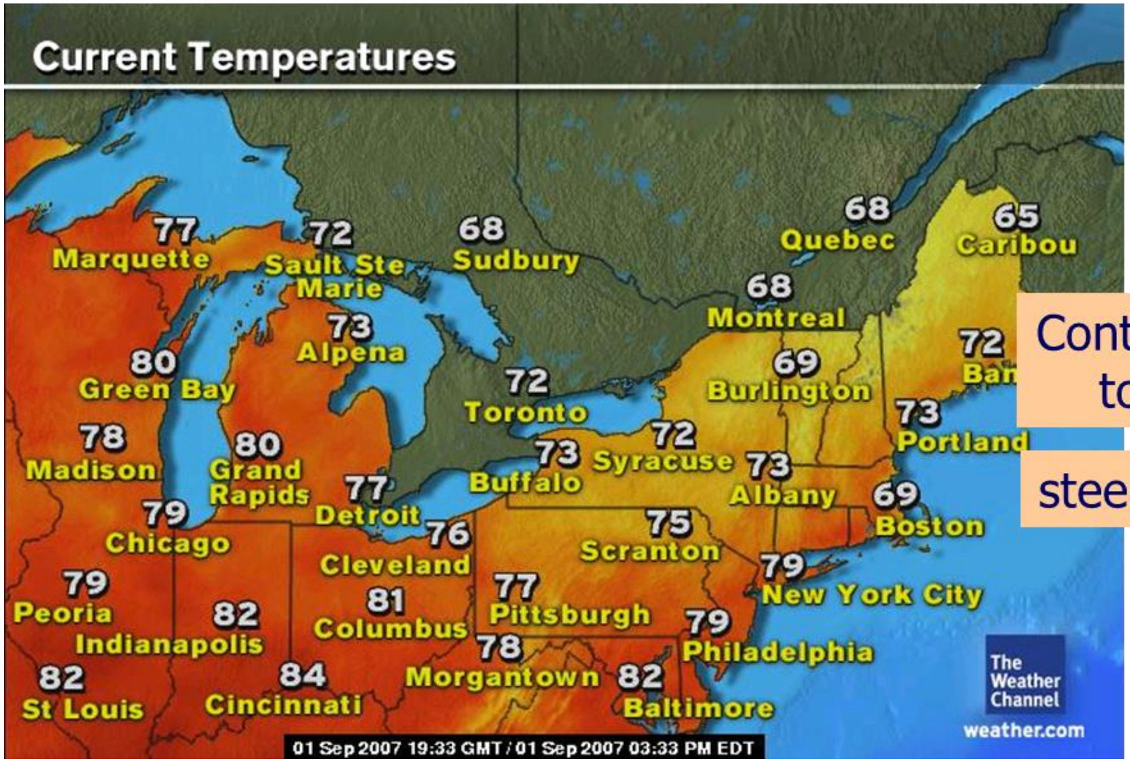
Eg. Temperature (°C)
Temperature distribution in the room with a heat source is a scalar field



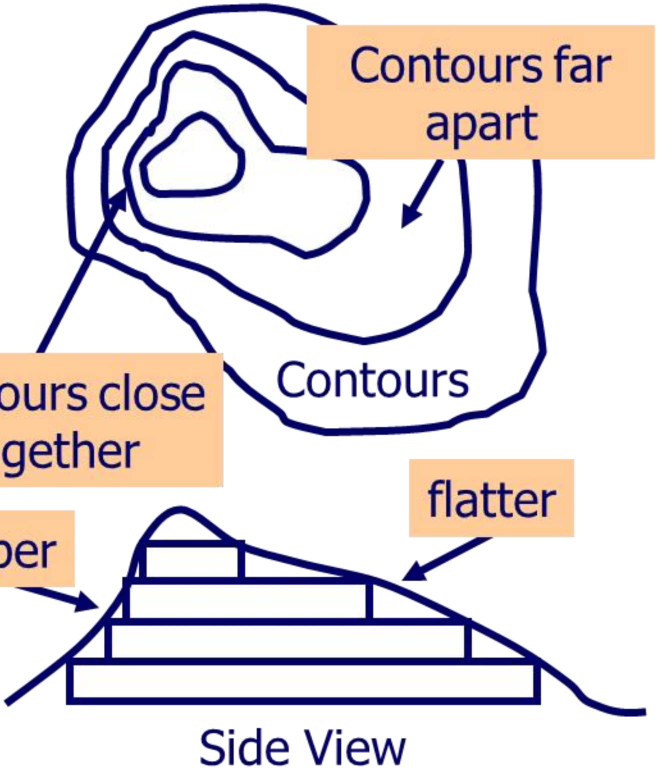
Pressure and electric potentials functions are other examples of scalar field

Scalar Fields

- A scalar field is just one where a quantity in "space" is represented by numbers, such as this temperature map.



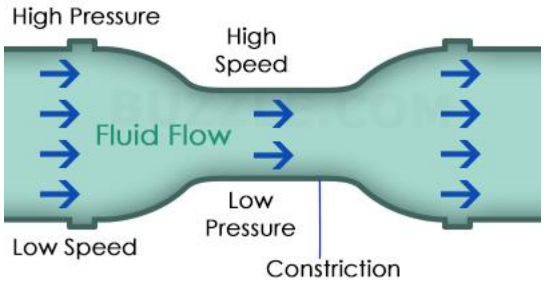
- Here is another scalar field, height of a mountain.



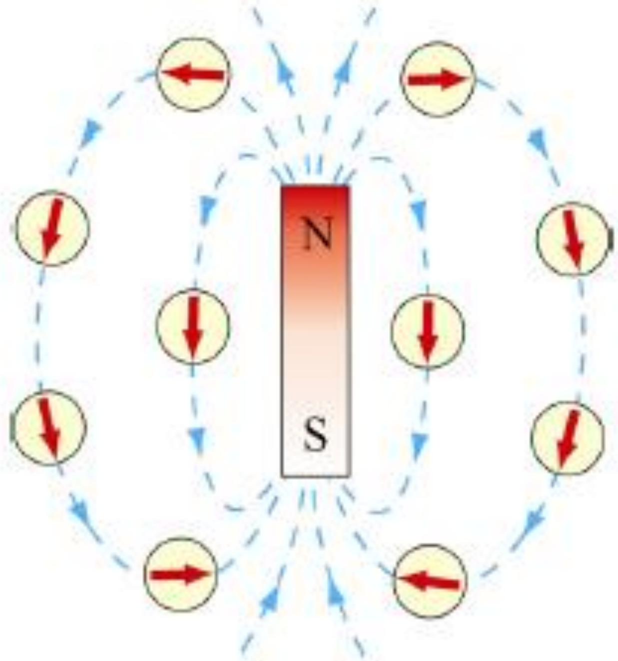
VECTOR FIELDS

A **vector** function defines a **vector field** in that domain or on that surface or curve

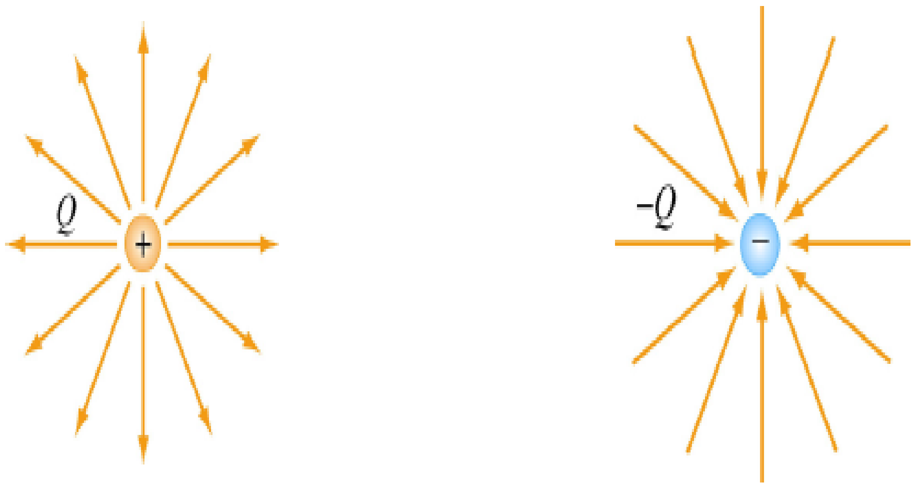
Eg. Velocity (m/s)
Velocity distribution of fluid flow through a tube of varying diameter is a vector field



Other examples of **vector fields** are **field** of tangent **vectors** of a curve, **field** of normal **vectors** of a surface, velocity **field** of a rotating body and the gravitational **field, electric field and magnetic field**



Magnetic field of a magnet



Electric field of positive and negative charges

Vector and scalar fields may depend also on time in addition to their dependencies on space.

Which one is a scalar field

a) Electric field
b) Magnetic field
c) Gravitational field
d) Pressure field

Which one is a vector field

a) Electric field
b) Temperature field
c) Pressure field
d) Electric potential

VECTOR CALCULUS

- Introducing mathematical operations in vector calculus for EM theory
- Study the rate of change of scalar and vector fields

Vector differential operator (∇)

-called Del or Nabla in

- Rectangular co-ordinate system (Cartesian)
- Cylindrical coordinate system
- Spherical polar coordinate system

1. DEL OPERATOR

In the Rectangular coordinate system

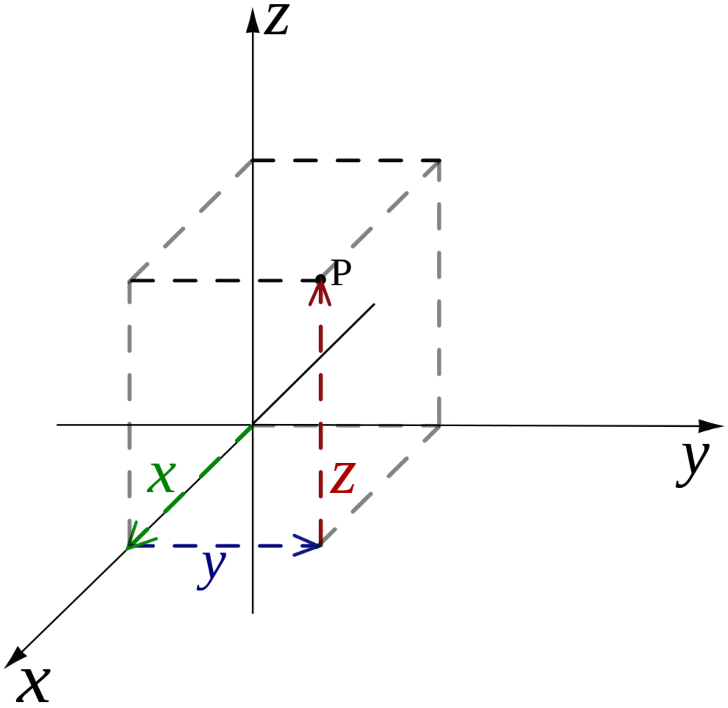
$$\vec{\nabla} = \hat{\boldsymbol{\imath}}\frac{\partial}{\partial x} + \hat{\boldsymbol{\jmath}}\frac{\partial}{\partial y} + \widehat{\boldsymbol{k}}\frac{\partial}{\partial z}$$

In the Cylindrical coordinate system

$$\vec{\nabla} = \hat{s}\frac{\partial}{\partial s} + \hat{\phi}\frac{1}{s}\frac{\partial}{\partial \phi} + \hat{\mathbf{z}}\frac{\partial}{\partial z}$$

In the spherical polar coordinate system

$$\vec{\nabla} = \hat{\boldsymbol{r}}\frac{\partial}{\partial r} + \hat{\theta}\frac{1}{r}\frac{\partial}{\partial \theta} + \hat{\phi}\frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}$$

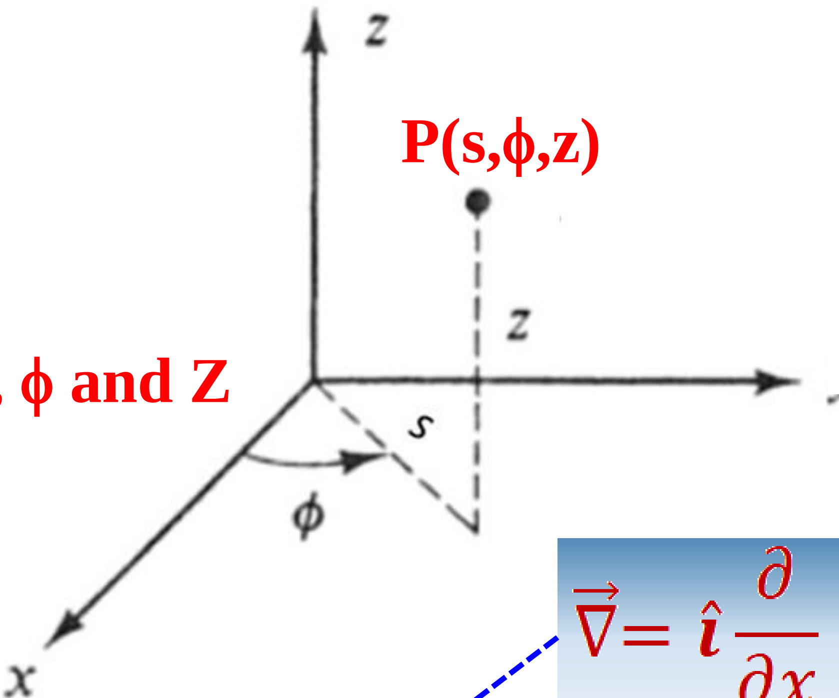


Refer T1: Mailk and Singh section 10.3 figure 10.1 to see the definition of (x,y,z), (s,ϕ,z) and (r,θ,ϕ)…Also depicted in the next slide

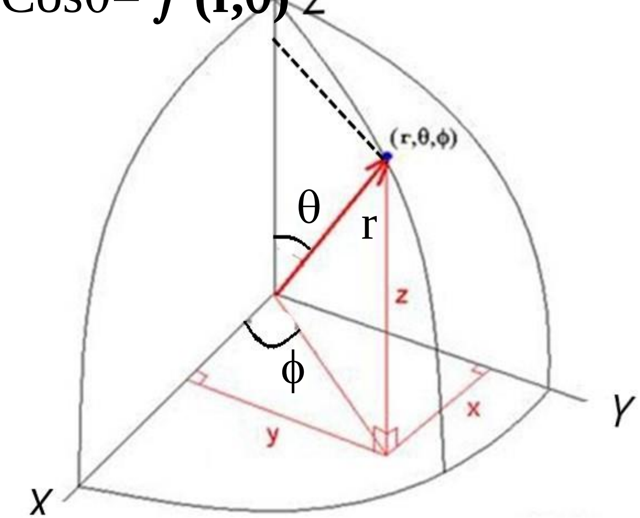
x=s cosϕ= ***f* (s,ϕ)**
y=s sinϕ= ***f* (s,ϕ)**
z= z

r-projection = r Sinθ= ***f* (r,θ)**
x=r-projection. Cosϕ = r Sinθ Cosϕ= ***f* (r,θ,ϕ)**
y=r-projection.Sinϕ = r Sinθ Sinϕ= ***f* (r,θ,ϕ)**
z= r Cosθ= ***f* (r,θ)**

S, ϕ and Z



r, ϕ,θ



$$\vec{\nabla} = \hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}$$

$$\vec{\nabla} = \hat{s}\frac{\partial}{\partial s} + \hat{\phi}\frac{1}{s}\frac{\partial}{\partial \phi} + \hat{z}\frac{\partial}{\partial z}$$

$$\vec{\nabla} = \hat{r}\frac{\partial}{\partial r} + \hat{\theta}\frac{1}{r}\frac{\partial}{\partial \theta} + \hat{\phi}\frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}$$

2. GRADIENT

In the rectangular coordinate, the Gradient of a Scalar function F(x,y,z)

Grad F(x,y,z)= $\vec{\nabla}F = \hat{\boldsymbol{\imath}}\frac{\partial F}{\partial x} + \hat{\boldsymbol{\jmath}}\frac{\partial F}{\partial y} + \widehat{\boldsymbol{k}}\frac{\partial F}{\partial z}$

$$\vec{\nabla}F = \frac{\partial F}{\partial s}\hat{s} + \frac{1}{s}\frac{\partial F}{\partial \phi}\hat{\phi} + \frac{\partial F}{\partial z}\hat{\mathbf{z}}$$

Cylindrical coordinate system

$$\vec{\nabla}F = \frac{\partial F}{\partial r}\hat{\boldsymbol{r}} + \frac{1}{r}\frac{\partial F}{\partial \theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial F}{\partial \phi}\hat{\phi}$$

Spherical coordinate system

2. GRADIENT; directional derivative

$$dF = \frac{\partial F}{\partial x}dx + \frac{\partial F}{\partial y}dy + \frac{\partial F}{\partial z}dz$$

dF is variation in F for a small change x, y and z

And is nothing but the dot product of ∇F with $\overrightarrow{dl} = \hat{\imath}dx + \hat{\jmath}dy + \hat{k}dz$

i.e….dF= $\vec{\nabla} F \bullet \overrightarrow{dl} = |\nabla F||dl|\cos\theta$

So maximum when θ=0; i.e when spatial change is in the direction of the vector ∇F

so…its gives an idea about the direction along which maximum change in the scalar function (F) occurs- and that will be in the direction of the vector $\vec{\nabla} F$

Which is/are correct statement(s)regarding the gradient of a scalar function (**F)**, $\vec{\nabla}F$

a) Maximum change in the scalar function (F) is along $\vec{\nabla}F$
b) It is a vector quantity
c) Both a and b
d) None of the above

3 DIVERGENCE

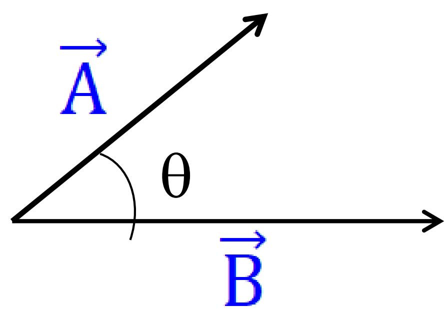
In the rectangular coordinate system, Divergence of the vector,

$\vec{A} = \hat{\imath}A_x + \hat{\jmath}A_y + \hat{k}A_z$ results in $\vec{\nabla}\bullet\vec{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$

$$(\hat{\imath}\frac{\partial}{\partial x} + \hat{\jmath}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z})\bullet \hat{\imath}A_x + \hat{\jmath}A_y + \hat{k}A_z$$

$$\hat{\imath}\cdot\hat{\imath} = \hat{\jmath}\cdot\hat{\jmath} = \hat{k}\cdot\hat{k} = 1;\ \hat{k}\cdot\hat{\imath} = \hat{k}\cdot\hat{\jmath} = \hat{\jmath}\cdot\hat{\imath} = 0\ and\ \hat{\imath}\cdot\hat{k} = \hat{\jmath}\cdot\hat{k} = \hat{\imath}\cdot\hat{\jmath} = 0$$

Vectors $\vec{A}$ and $\vec{B}$ with an θ between them



$$\vec{A}\cdot\vec{B} = AB\cos\theta$$

3 DIVERGENCE

$$\vec{\nabla}.\vec{A} = \frac{1}{s}\frac{\partial(sA_s)}{\partial s} + \frac{1}{s}\frac{\partial A_\phi}{\partial \phi} + \frac{\partial A_z}{\partial z}$$

Cylindrical coordinate system

$$\vec{\nabla}.\vec{A} = \frac{1}{r^2}\frac{\partial(r^2 A_r)}{\partial r} + \frac{1}{\mathrm{rsin\theta}}\frac{\partial(\sin\theta A_\theta)}{\partial \theta} + \frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial \phi}$$

Spherical coordinate system

Outward normal flux of vector field from a closed surface is Solenoidal if the divergence of the vector is zero..

What if the Divergence is ±x? Source ? Sink? Think about it…

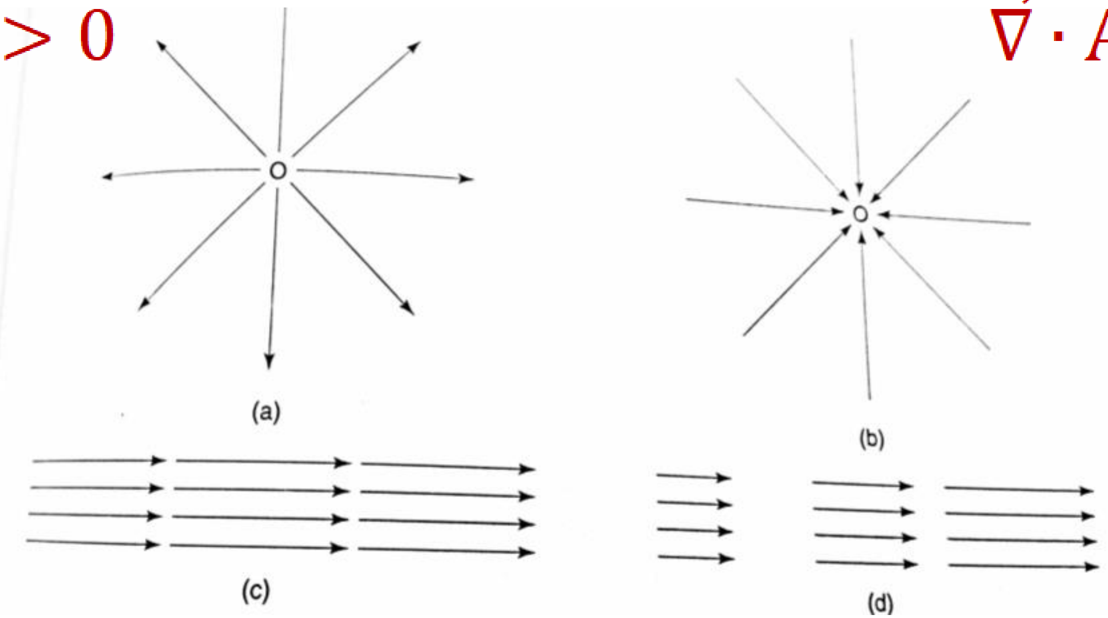
3 DIVERGENCE, source, sink or solenoidal

source

$$\vec{\nabla} \cdot \vec{A} > 0$$

sink

$$\vec{\nabla} \cdot \vec{A} < 0$$



$$\vec{\nabla} \cdot \vec{A} = 0$$

$$\vec{\nabla} \cdot \vec{A} > 0$$

solenoidal

If the divergence of the vector is zero i.e $\vec{\nabla} \cdot \vec{A} = 0$. Then that vector $\vec{A}$ is called

a) Solenoidal vector
b) Rotational Vector
c) Null vector
d) Unit vector

Curl of a vector

Rectangular coordinate system (x,y,z)

$$\vec{\nabla} \times \vec{A} = (\hat{\imath}\frac{\partial}{\partial x} + \hat{\boldsymbol{\jmath}}\frac{\partial}{\partial y} + \hat{\boldsymbol{k}}\frac{\partial}{\partial z}) \times (\hat{\imath}A_x + \hat{\jmath}A_{y+}\hat{k}A_z)$$

$$\hat{\imath}\times\hat{\imath} = \hat{\jmath}\times\hat{\jmath} = \hat{k}\times\hat{k} = 0;\ \hat{\imath}\times\hat{\jmath} = k;\ \hat{\jmath}\times\hat{k} = \hat{\imath};\ \hat{\imath}\times\hat{k} = -\hat{\jmath};\ \hat{\imath}\times\hat{\jmath} = -\hat{k};\ \hat{k}\times\hat{\jmath} = -\hat{\imath}; \hat{\imath}\times\hat{k} = -\hat{\jmath}$$

$$\vec{\nabla} \times \vec{A} = \hat{\imath}\left(\frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z}\right) + \hat{\jmath}\left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right) + \hat{k}\left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right)$$

$$\begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ A_x & A_y & A_z \end{vmatrix}$$

- Curl of a vector is a vector quantity--- as it has both magnitude and direction, and
    - is a rotational vector
    - Its magnitude is the maximum circulation per unit area
    - Its direction is normal to the area that make circulation maximum.. *Right hand rule*
- It is not possible to have the curl of a scalar quantity

Curl of a vector

Cylindrical coordinate system (s,ϕ,z)

$$\vec{\nabla}\times\vec{A} = \left(\frac{1}{s}\frac{\partial A_z}{\partial \phi} - \frac{\partial A_\phi}{\partial z}\right)\hat{s} + \left(\frac{\partial A_s}{\partial z} - \frac{\partial A_z}{\partial s}\right)\hat{\phi} + \frac{1}{s}\left(\frac{\partial (sA_\phi)}{\partial s} - \frac{\partial A_s}{\partial \phi}\right)\hat{z}$$

Spherical polar coordinate system (r,θ,ϕ)

$$\vec{\nabla}\times\vec{A} = \frac{1}{r\sin\theta}\left[\frac{\partial(\sin\theta\ A_\phi)}{\partial\theta} - \frac{\partial A_\theta}{\partial\phi}\right]\hat{r} + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial A_r}{\partial\phi} - \frac{\partial(rA_\phi}{\partial r}\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial(rA_\theta}{\partial r} - \frac{\partial A_r}{\partial\theta}\right]\hat{\phi}$$

If $\vec{\nabla}\times\vec{A} = 0$, we can say that vector A is irrotational or conservative vector field

If $\vec{\nabla}\times\vec{A} \neq 0$, then vector A is rotational vector and cross product gives the vorticity of the vector field A.. Not a conservative vector field

Which is the correct statement for the 'Curl of a vector' $\vec{\nabla} \times \vec{A}$?

a) Curl of a vector is a vector quantity.
b) Curl of a vector is a rotational vector
c) Curl of a vector is normal to the area that make circulation maximum.
d) It is not possible to have the curl of a scalar quantity.
e) All of the above
f) None of the above

UNIT:1 ELECTROMAGNETIC THEORY

20/01/23 Lecture 0: Introduction to PHY110, Zero Lecture

31/01/23 Lecture 1: Scalar and Vector Fields, Concept of Gradient, Divergence and Curl

01/02/3 Lecture 2: Gauss theorem and Stokes theorem (qualitative); Gauss law of electrostatics, Poisson, Laplace Equations, Continuity Equation

03/02/23 Lecture 3 Gauss law of magnetostatics, Faraday's law of electromagnetic induction, Ampere Circuital law, Maxwell's displacement current and corrections in Ampere Circuital Law

07/02/23 Lecture 4: Electric field, Displacement current, dielectric constant, Magnetic field and magnetic field strength, Maxwell's equation..

08/02/23 Lecture 5 Maxwell's Electromagnetic Equations (Differential and integral forms)

10/02/23 Lecture 6 Electromagnetic waves, Physical significance of Maxwell Equations, electromagnetic spectrum

14/08/23 Lecture 7: Application of 'EM' theory in resistive touch screen display, capacitive touchscreen display, Imaging devices

PHY109 – ENGINEERING PHYSICS

Text Books: ENGINEERING PHYSICS by HITENDRA K MALIK AND A K SINGH, MCGRAW HILL EDUCATION, 1st Edition, (2009)

References:

- ENGINEERING PHYSICS by B K PANDEY AND S CHATURVEDI, CENGAGE LEARNING, 1st Edition, (2009).
- ENGINEERING PHYSICS by D K BHATTACHARYA, POONAM TONDON OXFORD UNIVERSITY PRESS.
- FUNDAMENTALS OF PHYSICS by HALLIDAY D., RESNICK R AND WALKER J, WILEY, 9th Edition, (2011)