NAME	NEHAD MUHAMMAD
ID	14912
Course	Electromagnetic field
Instructor	Engr. Perniya Akram
Department	B-tech (E)
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Question 1.

Answer

Gradient

↳ Gradient is vector quantity.

↳ Gradient is applied on Scaler quantity.

↳ Gradient of function F can be calculated by

$$\text{Grad}(F) = \vec{\nabla} F = \frac{\partial F}{du} i + \frac{\partial F}{dy} j + \frac{\partial F}{dz} k$$

↳ It explains variation of function in x, y and z direction

Example

If we apply gradient to function of temprature, then from gradient we can understand rate of change of temprature in x, y and z direction

DIVERGENCE

- Divergence is scaler quantity.
- Divergence is applied on vector quantity.
- Divergence explains overall variation of function in x, y and z direction.
- It explains overall rate of change with respect to coordinates.
- Divergence of function $\vec{F}$ can be calculated by

$$Div(\vec{F}) = \vec{\nabla} \cdot \vec{F} = \frac{\partial F_1}{dx} + \frac{\partial F_2}{dy} + \frac{\partial F_3}{dz}$$

EXAMPLE

The divergence of a flow with no source or sink is 0. If there is a net source the divergence is positive and if there is a net sink the divergence is negative.

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Question 2:

find gradient of function at point (1, 1, 2) for $F = x^3 + y^3 z$.

Answer:

We know that Gradient of function F is

$$\text{Grad } F = \vec{\nabla} F = \frac{\partial F}{\partial x}\hat{i} + \frac{\partial F}{\partial y}\hat{j} + \frac{\partial F}{\partial z}\hat{k} \rightarrow (1)$$

Applay F is equal to $x^3 + y^3 z$ in equation (1)

$$\text{Grad } F = \vec{\nabla} F = \frac{\partial}{\partial x}(x^3 + y^3 z)\hat{i} + \frac{\partial}{\partial y}(x^3 + y^3 z)\hat{j} + \frac{\partial}{\partial z}(x^3 + y^3 z)\hat{k}$$

Now apply partial differential

So

$$\text{Grad } F = \vec{\nabla} F = (3x^2 + 0)\hat{i} + (0 + 3y^2 z)\hat{j} + (0 + y^3(1))\hat{k}$$

$$\text{Grad } F = 3x^2\hat{i} + 3y^2 z\hat{j} + y^3\hat{k}$$

Now at point (1, 1, 2) put $x = 1$ $y = 1$ $z = 2$

So $\text{Grad } F = \vec{\nabla} F = 3(1)^2\hat{i} + (3(1)^2(2))\hat{j} + (1)^3\hat{k}$

$$\text{Grad } F = \vec{\nabla} F = 3\hat{i} + 6\hat{j} + \hat{k}$$

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Question 3:

Compute div $\vec{F}$ and curl for $\vec{F} = x^2y\vec{i} - (z^3-3x)\vec{j} + 4y^2\vec{k}$

ANSWER:

We know that divergence of function $\vec{F}$ can be calculated by

$\star$ $Div(\vec{F}) = \vec{\nabla}\cdot\vec{F} = \frac{\partial F}{dx}\hat{i} + \frac{\partial F}{\partial y}\hat{y} + \frac{\partial F}{dz}\hat{k}$

$$Div(\vec{F}) = \vec{\nabla}\cdot\vec{F} = \frac{\partial F_1}{\partial x} \frac{\partial F_2}{\partial y} + \frac{\partial F_3}{d_z} \rightarrow (A)$$

put value in (A)

$$= \frac{\partial}{dx}(x^2y) + \frac{\partial}{dy}(-(z^3-3x)) + \frac{\partial}{d_z}(4y^2)$$

Now apply partial differential

$$= 2xy + 0 + 0$$

$$Div\ \vec{F} = \vec{\nabla}\cdot\vec{F} = 2xy$$

Now

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Function of Curl for $\vec{F}$ can be calculated by

★ $\text{Curl } \vec{F} = \vec{\nabla} \times \vec{F} = \begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ F_1 & F_2 & F_3 \end{vmatrix}$

put value in equation

$$\vec{\nabla} \times \vec{F} = \begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x^2y & -(z^3-3x) & 4y^2 \end{vmatrix}$$

$$= i \begin{vmatrix} \partial/\partial y & \partial/\partial z \\ -(z^3-3x) & 4y^2 \end{vmatrix} - j \begin{vmatrix} \partial/\partial x & \partial/\partial z \\ x^2y & 4y^2 \end{vmatrix}$$

$$+ k \begin{vmatrix} \partial/\partial x & \partial/\partial y \\ x^2y & -(z^3-3x) \end{vmatrix}$$

$$= i\left(\frac{\partial}{\partial y}(4y^2) - \frac{\partial}{\partial z}(-z^3+3x)\right) - j\left(\frac{\partial}{\partial x}(4y^2)\right.$$

$$\left. - \frac{\partial}{\partial z}(x^2y)\right) + k\left(\frac{\partial}{\partial x}(-z^2+3x) - \frac{\partial}{\partial y}(x^2y)\right)$$

$$= i(8y - (-3z^2+0)) - j(0-0) + k((0+3) - x^2)$$

$$= i(8y+3z^2) + 0j + (3-x^2)k$$

$$\text{Curl } \vec{F} = \vec{\nabla} \times \vec{F} = i(8y+3z^2) + 0j + (3-x^2)k$$

Ans

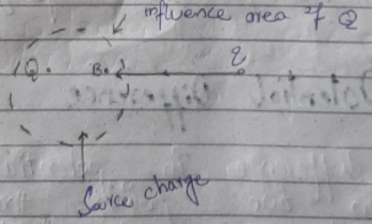
QUESTION 4

Answer

Electric Potential

Electric potential is the amount of work needed to move a unit of charge from a reference point to a specific point inside the field without producing an acceleration

Example



Lets this point is infinity and here a charge is placed
Suppose q

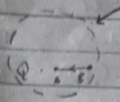
Suppose A source charge is

placed so it has some influence space around it where it can effect other charges around it. So if we have to bring one point charge which is placed outside influence area suppose placed at infinity, to inside space of source charge some work has to be done and that work is restored as a potential of that charge that potential is known electric potential

$$\text{Electric potential} = \frac{\text{work done}}{\text{charge}(q)}$$

Potential Difference

The difference in potential between two points that represents the work involved or the energy released in the transfer of a unit quantity of electricity from one point to another.



The figure show that the test charge is already placed inside influence area of source charge so it already got some amount of electric potential if test charge move between two point with in influence of source charge there with the differences in the potential across those two point so this is called potential difference.

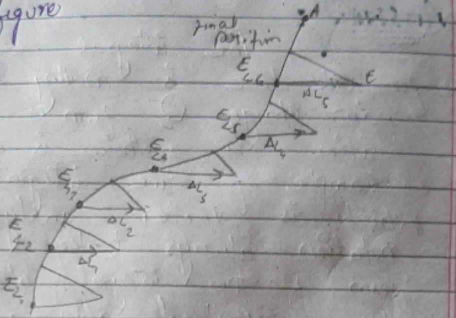
$$\text{potential difference} = \frac{\text{work done}}{q}$$

Question 5

Answer: The integral expression for work done is moving a point charge Q from one position to another is an example of line integral. which is vector analysis notation always takes the form of the integral along some prescribed path of the Dot product.

A line integral is like many other integrals which appearing in advanced analysis the surface appearing in in Gauss's Law. It tell us choose a path break it up into a large number of very small segments, multiply the component of the field along each segment by the length of the segment and the add the result of all segment. The integral is obtained directly

directly when the number of segment become infinite. This procedure is indicate in figure



The path is divided into six segment. $\Delta L_1, \Delta L_2, \Delta L_3 \ldots \Delta L_6$ And the component of E along each segment denoted by $E_{L_1}, E_{L_2} \ldots E_{L_6}$. The work involved a charge Q from B to A is then approximately.

A graphical interpretation of a line integral in a uniform field. The line integral of E between point B and A is independent of the path selected.