Department of Electrical Engineering
Final Term Assignment Spring 2020
B.tech(E)
Date: 22/06/2020

Course Details

Course Title:	Electromagnetic Fields	**Module:**	4th
Instructor:	Engr.Perniya Akram	**Total Marks:**	50

Student Details

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Note: Attempt all of the following questions.

Q1.	State the differences and similarity between gradient and divergence providing relevant example.	Marks 10
Q2.	Find gradient of function F at point(1,1,2) for $F=x^3+y^3z$.	Marks 10
Q3.	Compute $\mathbf{div}\vec{F}$ and $\mathbf{curl}\vec{F}$ for $\vec{F} = x^2y\,\vec{i} - (z^3 - 3x)\,\vec{j} + 4y^2\vec{k}$.	Marks 10
Q4.	State the relationship between electric potential and potential difference with examples.	Marks 10
Q5.	Find the expression for moving a point charge Q from one position to another by using Line integral.	Marks 10

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Q1: State the differences and similarity between gradient and divergence providing relevant example.

ANS:

There are many differences between a gradient and a divergence.

To start with, the gradient is a differential operator that operates on a scalar field, while the divergence is a differential operator that operates on a vector field (just as the curl is also a differential operator that operates on a vector field)

The result of a gradient is a vector field, while the result of a divergence is a scalar field.

The gradient is a vector field with the part derivatives of a scalar field, while the divergence is a scalar field with the sum of the derivatives of a vector field.

As the gradient is a vector field, it means that it has a vector value at each point in the space of the scalar field. Any given vector has a direction (any given vector points towards a given direction): at each given point in the space of the scalar field, the gradient is the vector that points towards the direction of greatest slope of the scalar field at each point.

The divergence of a vector field is a scalar field that measures the net flow of the vector field at each given point in the space of said vector field.

EXAMPLE OF GRADIENT:

the "distance from the origin" function, f(x)=$\sqrt{x^2y^2z^2}$ has the gradient

$$\nabla f = \frac{(x,y,z)}{\sqrt{x^2y^2z^2}},$$

Which gives vectors pointing radially away from the origin, the "fastest" way to get farther from the origin?

EXAMPLE OF DIVERGENCE:

An example for divergence: the *vector* function, g→(x,y,z)=⟨x2,y2,z2⟩ ,g→(x,y,z)=⟨x2,y2,z2⟩ , which has the divergence

∇·g→ = 2x+2y+2z, ∇·g→ = 2x+2y+2z,

Which indicates that, for a quantity which is getting larger with increasing distance from the origin, the amount of flow outward through an imaginary surface at some radius from the origin is also getting stronger.

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Q2: Find gradient of function F at point(1,1,2) for F=x^3+y^3z.

ANS:

SOLUTION:

We know that gradiant of function F is

Solution

$\nabla\vec{F} = \frac{aF}{ax}\underset{i}{\rightarrow} + \frac{aF}{ay}\underset{j}{\rightarrow} + \frac{aF}{az} + \underset{k}{\rightarrow}$

Apply F is equal to x^3y^3z in equation (1)

Grad F =$\nabla\vec{F}$ = $\frac{a(x^3y^3z)}{ax}$ i^+ $\frac{a(x^3y^3z)}{ay}$ –j^ $\frac{a(x^3y^3z)}{az}$ k^

Now apply partial diffrenet

So
Grad F = $\nabla\vec{F} = (3x^2+o)i\hat{} + (o+33y^2z)j\hat{} + (o+y^3(1))K\hat{}$

Grad F + $\nabla\vec{F}$ = $3x^2i\hat{} + 3y^2zj\hat{} + y^3k\hat{}$

Now

At point(1,1,2) put x=1 ,y=1 ,z=2

So grad F =$\nabla\vec{F}$ = $3(1)^2$ i^ + 3 $(1)^2(2)^2$j^ +$(1)^2$K^

Grad F = $\nabla\vec{F}$ +- 3i^+ 6j^+K^

ANS…

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Q3: Compute $\operatorname{div}\vec{F}$ and $\operatorname{curl}\vec{F}$ for $\vec{F} = x^2y\,\vec{i} - (z^3 - 3x)\,\vec{j} + 4y^2\vec{k}$.

SOLUTION:

Let's compute the divergence first and there isn't much to do other than run through the formula.

$$\text{Div } \vec{F} = \nabla \cdot \vec{F} = \frac{a}{ax}(x^2y) + \frac{a}{ay}(3x\text{-}z^2) + \frac{a}{a_z}(4y^2) = 2xy$$

$$\text{Curl } \vec{F} = \nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{a}{ax} & \frac{a}{ay} & \frac{a}{az} \\ x^2y & 3x - z^3 & 4y^2 \end{vmatrix}$$

$$= \frac{a}{ay}(4y^2)\vec{i} + \frac{a}{az}(x^2y)\vec{j} + \frac{a}{ax}(3x - z^3)\vec{k} - \frac{a}{ay}(x^2y)\vec{k} - \frac{a}{ax}(4y^2)\vec{j}\,\frac{a}{az}(3x - z^3)\vec{i}$$

$$= 8y\vec{i} + 3\vec{k} - x^2\vec{k} + 3z^2\vec{i}$$

$$= (8y + 3z^2)\vec{i} + (3 - x^2)\vec{k}\ .$$

Ans.

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Q4: State the relationship between electric potential and potential difference with examples.

ANS:

Electric Potential & Potential Difference

ELECTRIC POTENTIAL:

Definition:

The electrical potential is defined as the capability of the charged body to do work. When the body is charged, either electric electrons are supplied to it, or they are removed from it. In both the cases, the work is done. This work is stored in the body in the form of electric potential. Thus, the body can do the work by exerting a force of attraction or repulsion on the other charged particles.

The capacity of the charged body to do work determines the electrical potential on it. The measure of the electrical potential is the work done to charge a body to one coulomb, i.e.

Units:

Since the work done is measured in joules and charge in coulombs, the unit of electric potential is joules /coulombs, the unit of electric potential is joules/coulomb or volts.

EXAMPLE:

Like a bowling ball sitting at the top of a tower, a positive charge in close proximity to another positive charge has a high potential energy; left free to move, the charge would be repelled away from the like charge.

FORMULA :

$$V=K\frac{Q}{r}$$

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Electric Potential Difference:

The electrical potential difference is defined as the amount of work done to carrying a unit charge from one point to another in an electric field. In other words, the potential difference is defined as the difference in the electric potential of the two charged bodies.

When a body is charged to a different electric potential as compared to the other charged body, the two bodies are said to a potential difference. Both the bodies are under stress and strain and try to attain minimum potential

Unit: The unit of potential difference is volt

EXAMPLE:

every battery has two terminals, and its voltage is the potential difference between them. More fundamentally, the point you choose to be zero volts is arbitrary. This is analogous to the fact that gravitational potential energy has an arbitrary zero, such as sea level or perhaps a lecture hall floor. It is worthwhile to emphasize the distinction between potential difference and electrical potential energy

Q5: Find the expression for moving a point charge Q from one position to another by using Line integral.

ANS:

The integral expression for the work done in moving path a point charge Q from one position to another is an example of a line integral, which in vector analysis notation always taken the form of the integral along some prescribe path of the dot product of a vector field and a differential vector path length dl without using vector analysis we should have to write

$$W= -Q \int_{initial}^{final} El\ dl$$

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Where El = component of E along dL
a line integral is like many other integral which appear in advanced analysis including the surface integral appearing in gauss's law in that it is essentially descriptive we like to look at it much more than we like to work it out it tells us to chose a path break it up into large number of very small segments multiply the component of the field along each segment by length of the segment and then add the result for all segments this summation of cause and the and the integral is obtained exactly only when the number of segment becomes infinite .

Where path has been chosen from an initial position B to a final position A and uniform electric field selected foe simplicity, the path is divided into six segment

Δl_1,Δl_2 ……….Δl_6 and the components is moving a charge Q to B to A then approximately

$$W = -Q(E_{l1}\Delta l_1 + E_{l2} + \ldots\ldots\ldots + E_{L6}\Delta_{L6}$$

Or using vector notation

$$W = -Q(E_1 . \Delta L_1 + E_{L2} . \Delta L_2 + \ldots\ldots + E_6 \Delta L_6$$