ENGINEERING PHYSICS

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Week #1

Cl#1 Review of Electric and magnetic fields

Cl#2 EM Wave equation

Cl#3 Energy transported by EM Waves

Cl#4 Max Planck's Black Body Radiation equation

- *Suggested Reading*
  1. *Fundamentals of Physics, Resnik and Halliday, Chapters 22,29, 32*
  2. *NCERT Physics Book I grade 12 Chapters 1,4,6*

- *Reference Videos*
  1. *https://nptel.ac.in/courses/108/106/108106073/*

Class #1

- Review of Electric and magnetic fields
- Concept of the Nabla operator ∇
- Gradient, Divergence and Curl Operations
- Divergence and curl of fields

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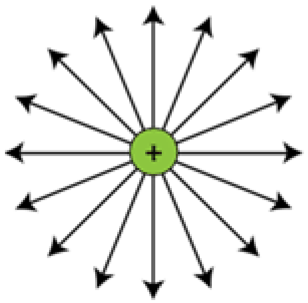
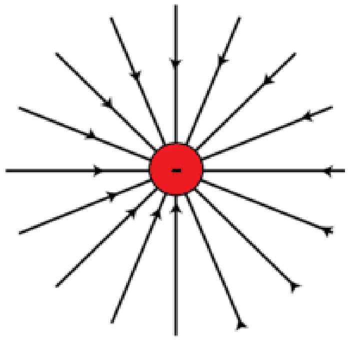
Electric Charges

- *Electric charges can be isolated*
- *The potential at any point x from the charge*
- $V_x = \frac{Q}{4\pi\varepsilon_o} \times \frac{1}{x}$
- *The electric field due to a point charge*
- $E_x = \frac{Q}{4\pi\varepsilon_o} \times \frac{1}{x^2}$
- *The electric field in terms of the potential*
- $E_x = -\frac{dV_x}{dx}$

Electric fields can be visualized through the electric flux lines1

Electric field lines from positive and negative charges





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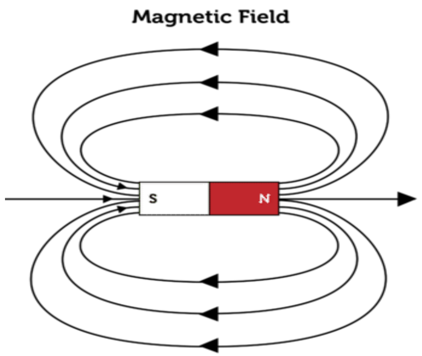
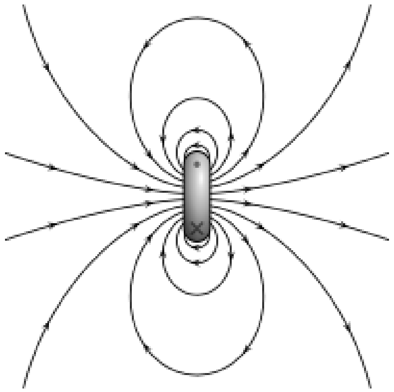
Concepts of Magnetic fields

Magnetic dipoles

- ***Magnetic mono poles do not exist***
- ***Fields can be expressed in terms of the flux lines***
- ***Flux lines are continuous from the north pole to the south pole***

Magnetic field lines of a magnetic dipole





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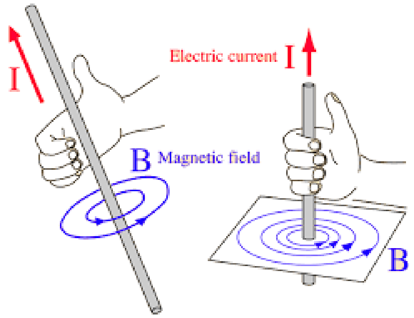
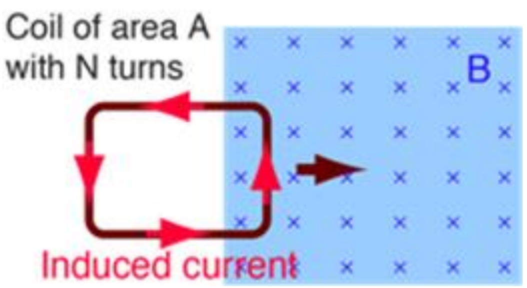
Electric and Magnetic fields

- *Electric currents are due to moving charges*
- *Magnetism and magnetic fields are due to moving charges*

Interplay of electric currents and Magnetic fields



Ampere's law



Faraday's law

Images courtesy Hyperphysics, Wikipedia

Operations with Del or Nabla operator - $\vec{\nabla}$

Operations with the Nabla operator (del operator)

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

- $\vec{\nabla}$ operates on a scalar to give a vector

  - Gradient of the scalar

- The dot product (.) of ∇ with a vector gives a scalar

  - Divergence of the vector

- The cross product (x) of ∇ with a vector gives a vector

  - Curl of the vector

Gradient of a scalar field

Gradient of a scalar $V(xyz)$

$$grad\,V = \nabla V = \hat{\imath}\frac{\partial V_x}{\partial x} + \hat{\jmath}\frac{\partial V_y}{\partial y} + \hat{k}\frac{\partial V_z}{\partial z}$$

The gradient of a scalar field gives a vector

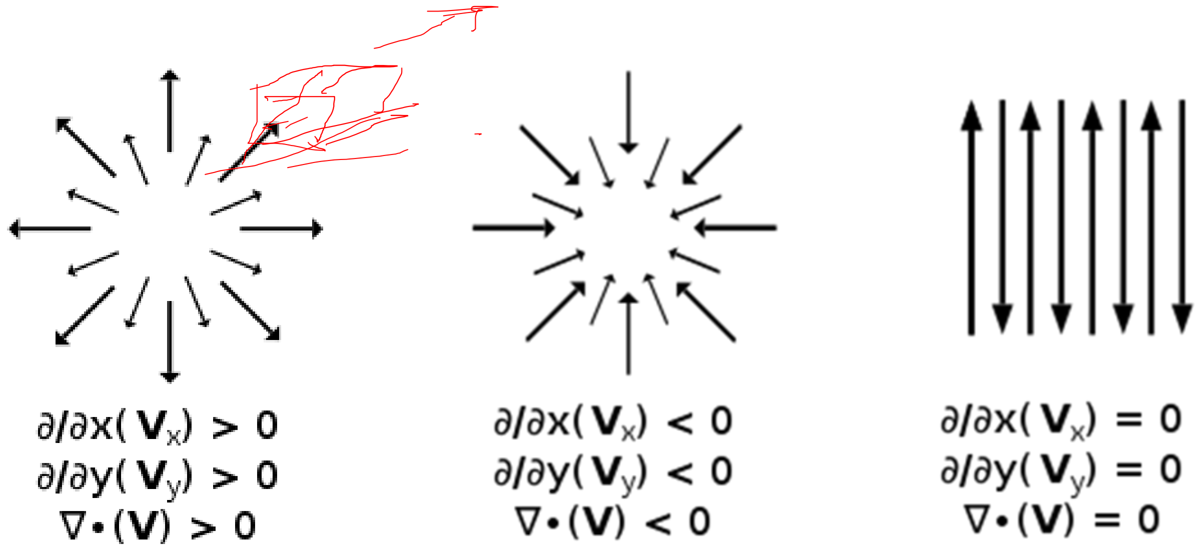
Gradient gives the rate of change of the property at any point and the direction gives the direction in which the change is maximum

Divergence of a vector field

Divergence of a vector $\vec{V} = \hat{i}V_x + \hat{j}V_y + \hat{k}V_z$

$$Div\, V = \nabla . V = \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z}$$

The divergence of a vector field gives a scalar



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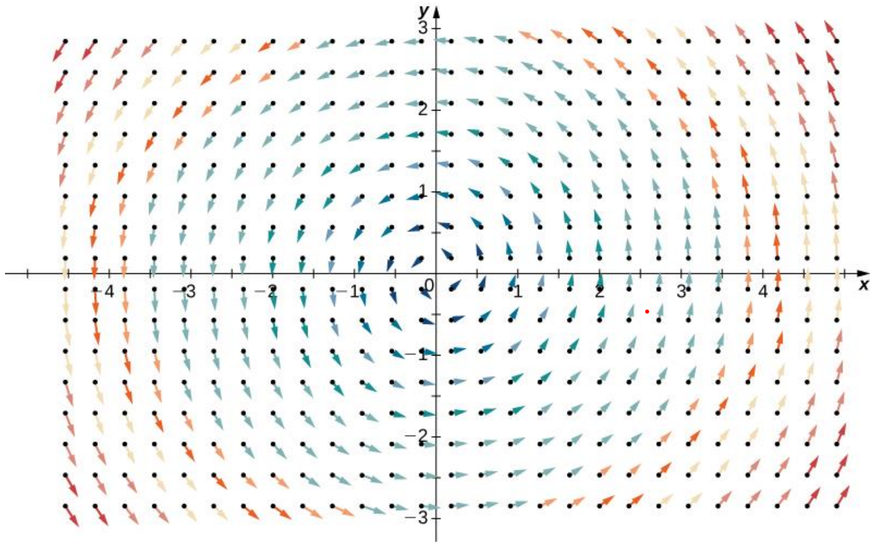
Curl of a vector field

$$curl\, A = \nabla \times A = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ A_x & A_y & A_z \end{vmatrix}$$

The curl of a vector is another vector



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Curl of a vector field

- $\vec{\nabla}.\vec{\nabla} = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} \quad = \nabla^2$ ..... *Laplacian operator*
- $\vec{\nabla} \times (\vec{\nabla} \times A) = \vec{\nabla}(\vec{\nabla}.A) - \nabla^2 A$ ..... *Vector identity*

The curl of a vector is another vector

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Class 1 . Quiz …

The concepts which are correct are….

1. Electric monopoles do not exist
2. Magnetic dipoles exist
3. Magnetic monopoles do not exist
4. Electric dipoles can be observed in systems
5. Magnetic lines of force are divergent
6. Electric flux lines are always divergent

THANK YOU

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