ECE 220 Disc 1

1/25/2006

Definition of Gradient, Divergence, Curl

Gradient

- "The vector which gives both the magnitude and direction of the maximum spatial rate of change of a scalar function is called the gradient of this scalar function"
- Operates on a scalar
- Results in a vector

Divergence:

- "The divergence of vector **A** is the net flow of the flux of vector **A** out of a small volume, through the closed surface enclosing the volume, as the volume tends to zero."
- Operates on a vector
- Results in a scalar

Curl

- The curl of **A** is the circulation (**line integral**) of the vector **A per unit area**, as this area tends to zero and is in the direction **normal to the area** when the area is oriented such that the circulation is maximum."
- Operate on a vector
- Result on a vector

Definition of Electric Field and voltage

Electric Field:

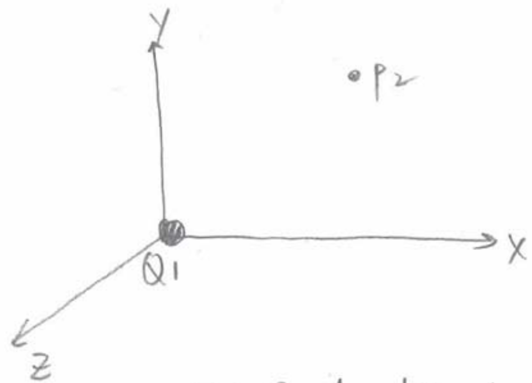
- force exerted on a positive unit charge (1C)
- direction of the field is the direction of the force

Voltage:

- Voltage at a point is the work done in moving a unit positive charge from an infinite distance to that point
- Voltage difference between two points A and B is the amount of work done in moving a unit positive charge(1C) from A to B.

* Engineering Electromagnetism by Ida
* ECE 220 course webpage

Electric Field Due to Point Charge



$\varepsilon_0 = 8.854 \times 10^{-12} \left(\frac{F}{m}\right)$

① Coulomb's Law

Put a charge at P_2

$$\vec{F}_2 = \vec{E}_2 Q_2$$

$$= \hat{R}_2 \frac{Q_1 Q_2}{4\pi\varepsilon_0 |R_2|^2}$$

$$E_2 = \frac{\vec{F}_2}{Q_2} = \hat{R}_2 \frac{Q_1}{4\pi\varepsilon_0 |R_2|^2}$$

② Gauss's Law

$$\oint_s \vec{D} \cdot d\vec{S} = Q$$

D = electric flux density.

total charge enclosed by the sphere

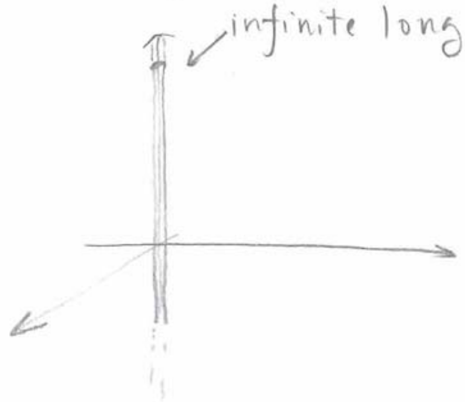
$$\oint_s \vec{E} \cdot d\vec{S} = \frac{Q}{\varepsilon_0}.$$

surface integral

$$\vec{E} = \hat{R} \frac{Q}{4\pi\varepsilon_0 R^2}$$

peameability $\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}$

Magnetic Field Intensity due to a wire



$\oint H\, dl = I_{enclosed}$

line integral

$H = \frac{I}{2\pi R}$

$B = \mu_0 H = \frac{\mu_0 I}{2\pi R}$