EE468G NOTES (3)

Contents: Static Fields

Vector operations
Differential operatiors
Integrals (volume, surface, line)
Coulomb's Law and Gauss' Law
Potential functions
Boundary condition

Sources for electromagnetic fields

Charge (Q):

Unit: Coulomb, [C]
Polarization: positive, negative
Elemental charge partical: electron and proton
Electron charge = -1.60210×10^{-19} $[C]$
Point charges
Charge distribution: volume, surface, line

Volume charge density: ρ_V, $Q=\int_V \rho_V(x,y,z)\,dV$

Surface charge density: ρ_S

Line charge density: ρ_l

Law of conservation of charge: The total charge in a closed system remain the same for all time.

Current (I):

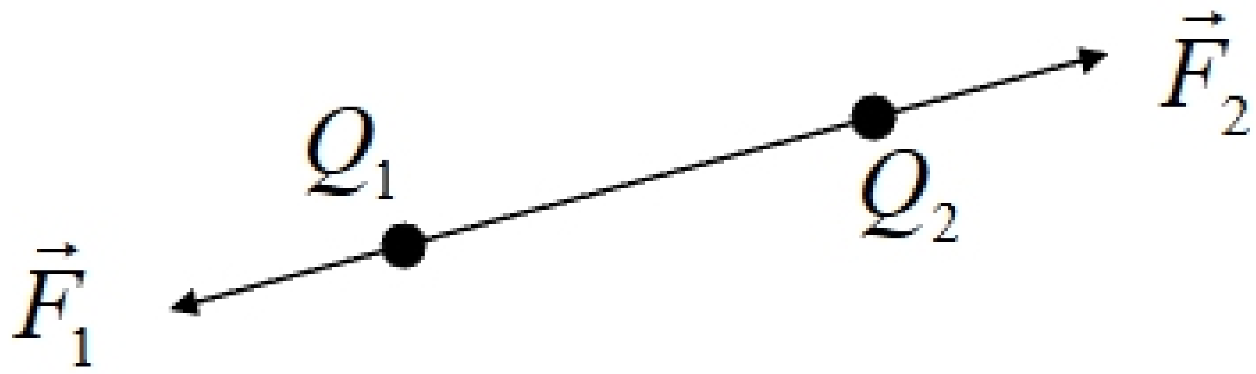
Flow of charges (Rate of change in charge)
Unit: Ampere, [A], or [C/s]
Direction: positive charge moving direction.
Current = integral of current density
Volume current density: [$\mathrm{A/m^2}$], Symbol: $\vec{J}$
Surface current current density: [A/m], $\vec{J}_S$

Continuity relation:

Integral format: $\oint_S \vec{J}\cdot d\vec{S} = -\dfrac{\partial Q_{\text{enc}}}{\partial t}$,

Differential format: $\nabla\cdot\vec{J} = -\dfrac{\partial \rho_V}{\partial t}$

Two point charges suspended in free-space will act a force to each other.



Consider one charge in space. It has the ability to act a force to a charge if it is put into the space. We use a test charge to examine the force. If the testing charge has charge Q, the force acting on it is F, then, the ***electric field intensity*** is defined as:

$$\vec{E} = \lim_{Q \to 0} \frac{\vec{F}}{Q}, \qquad [\text{ N/C, or V/m}]$$

Lorentz force: The forces act on a test charge Q by the fields.

$$\vec{F} = Q\left(\vec{E} + \vec{u} \times \vec{B}\right) = Q\vec{E} + Q\vec{u} \times \vec{B}$$

The first term is the electric force, it defines electric field intensity

The second force is the magnetic force (acts on a moving charge), it defines magnetic flux density.