# Engineering Electromagnetics

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## 3.1 Charge

Line Charge Density

$$\rho_l = \lim_{\Delta l \to 0} \frac{\Delta Q}{\Delta l} \qquad \left[\frac{\mathrm{C}}{\mathrm{m}}\right]$$

Surface Charge Density

$$\rho_s = \lim_{\Delta s \to 0} \frac{\Delta Q}{\Delta s} \quad \left[\frac{\mathrm{C}}{\mathrm{m}^2}\right]$$

Volume Charge Density

$$\rho_v = \lim_{\Delta v \to 0} \frac{\Delta Q}{\Delta v} \quad \left[\frac{\mathrm{C}}{^3}\right]$$

## 3.2 Coulomb's Law

$$\vec{F} = k\frac{Q_1 Q_2}{r^2}\hat{r} \quad [\mathrm{N}]$$

$$k = \frac{1}{4\pi\epsilon} \quad \left[\frac{Nm^2}{C^2}\right]$$

### 3.3 Electric Field

$$\vec{E} = \lim_{Q \to 0} \frac{\vec{F}}{Q} \quad \left[\frac{N}{C}\right]$$

### 3.4 Electric Flux

Electric Flux Density

$$\vec{D} = \vec{E} \quad \left[\frac{C}{m^2}\right]$$

Electric Flux

$$\Phi = \int_S \vec{D} \cdot d\vec{s} \quad [C]$$

## 4 Electric Potential

### 4.1 Electristatic Field

Postulates for the Electrostatic Field:

$$\begin{cases} \boldsymbol{\nabla} \cdot \vec{E} = \frac{\rho_v}{\epsilon_0} \\ \nabla \times \vec{E} = 0 \end{cases}$$

$$\begin{cases} \oint_S \vec{E} \cdot d\vec{s} = \frac{Q}{\epsilon_0} = 0 \\ \oint_C \vec{E} \cdot d\vec{l} = 0 \end{cases}$$

### 4.2 Gauss's Law

$$\oint_s \vec{D} \cdot d\vec{s} = Q \quad [C]$$

$$\oint_s \vec{E} \cdot d\vec{s} = \frac{Q}{\epsilon_0}$$

### 4.3 Electric Potential

Scalar Electric Potential

$$V_{ba} = \frac{W}{Q}$$