1 Coordinate Systems

1.1 Cartesian Coordinates

Definition:

- Position vector

$$\mathbf{R} = x\mathbf{a}_x + y\mathbf{a}_y + z\mathbf{a}_z \tag{1}$$

- Differential length elements

$$\mathbf{dl}_x = \mathbf{a}_x dx, \quad \mathbf{dl}_y = \mathbf{a}_y dy, \quad \mathbf{dl}_z = \mathbf{a}_z dz \tag{2}$$

- Differential surface elements

$$\mathbf{dS}_x = \mathbf{a}_x dydz, \quad \mathbf{dS}_y = \mathbf{a}_y dzdx, \quad \mathbf{dS}_z = \mathbf{a}_z dxdy \tag{3}$$

- Differential volume elements

$$dV = dxdydz \tag{4}$$

1.2 Cylindrical Coordinates

Definition:

- Position vector

$$\mathbf{R} = r\mathbf{a}_r + z\mathbf{a}_z \tag{5}$$

- Differential length elements

$$\mathbf{dl}_r = \mathbf{a}_r dr, \quad \mathbf{dl}_\phi = \mathbf{a}_\phi r d\phi, \quad \mathbf{dl}_z = \mathbf{a}_z dz \tag{6}$$

- Differential surface elements

$$\mathbf{dS}_r = \mathbf{a}_r dzdr, \quad \mathbf{dS}_\phi = \mathbf{a}_\phi r dzd\phi, \quad \mathbf{dS}_z = \mathbf{a}_z drd\phi \tag{7}$$

1.3 Spherical Coordinates

Definition:

2 Electric Field

2.1 Coloumb's Law

Definition:

$$\mathbf{F}_{12} = \frac{q_1 q_2}{4\pi\epsilon_0} \frac{\mathbf{R}_2 - \mathbf{R}_1}{|\mathbf{R}_2 - \mathbf{R}_1|^3} \tag{8}$$

2.2 Guass Law

Definition:

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0} \tag{9}$$

$$\oint_S \mathbf{E} \cdot \mathbf{dS} = \frac{Q_{\text{enc}}}{\epsilon_0} \tag{10}$$

3 Electrostatics

3.1

4 Magnetostatics

4.1

5 Faraday's Law, Ampere-Maxwell Law

5.1

6 Currents

6.1