1.6: Notation

Learning Objectives

By the end of this section, you will be able to

- Identify the mathematical notation used in this book.

The list below describes the notation used in this book. If you have not seen some of this notation or terminology before, do not worry! The notation or terminology will be covered again in the body of the text.

- *Time*: The symbol t indicates time.
- *Position*: The symbols (x, y, z), (ρ, ϕ, z), and (r, θ, ϕ) indicate positions using the Cartesian, cylindrical, and polar coordinate systems, respectively. It is sometimes convenient to express the position coordinate in a manner that is independent of a coordinate system; in this case, we typically use the symbol $\vec{r}$. For example, $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ in the Cartesian coordinate system.
- *Vectors:* A symbol that is in boldface and/or with an arrow on top is used to indicate a vector; e.g., the electric field vector will typically appear as $\vec{E}$ or $\mathbf{E}$ or $\vec{\mathbf{E}}$. The scalar magnitudes are typically written in italics without an arrow on top, e.g., E can denote the magnitude of the electric field vector.
- *Unit vectors:* A circumflex ("hat" symbol) is used to indicate a unit vector; i.e., a vector having magnitude equal to one. For example, the unit vectors pointing in the $+x$, $+y$, $+z$ directions are indicated using the lowercase unit vectors $\hat{i}$, $\hat{j}$, $\hat{k}$, respectively. In discussion, the quantity "$\hat{i}$" is typically spoken "i hat." Note that the Cartesian unit vectors are sometimes also indicated by $\hat{x}$, $\hat{y}$, $\hat{z}$ for consistency of notation with unit vectors in other non-Cartesian coordinate systems.
- *Curves, surfaces, and volumes*: These geometrical entities will usually be indicated by single capital letter in italics or script; e.g., an open surface might be indicated as $\mathcal{S}$ and the curve bounding this surface might be indicated as $\mathcal{C}$. Similarly, the volume enclosed by a closed surface $\mathcal{S}$ may be indicated as $\mathcal{V}$.
- *Integrations over curves, surfaces, and volumes* will usually be indicated using a single integral sign with the appropriate subscript. For example:

$$\int_{\mathcal{C}} \cdots dl \text{ is an integral over the curve } \mathcal{C}$$

$$\int_{\mathcal{S}} \cdots ds \text{ is an integral over the surface } \mathcal{S}$$

$$\int_{\mathcal{V}} \cdots ds \text{ is an integral over the volume } \mathcal{V}.$$

- *Integrations over closed curves and surfaces* will be indicated using a circle superimposed on the integral sign. For example:

$$\oint_{\mathcal{C}} \ldots dl \text{ is an integral over the closed curve } \mathcal{C}$$

$$\oint_{\mathcal{S}} \ldots ds \text{ is an integral over the closed surface } \mathcal{S}$$

  A "closed curve" is one which forms an unbroken loop; e.g., a circle. A "closed surface" is one which encloses a volume with no openings; e.g., a sphere.
- *Phasors:* A tilde over a symbol is used to indicate a phasor quantity; e.g., a voltage phasor might be indicated as $\tilde{V}$, and the phasor representation of $\mathbf{E}$ will be indicated as $\tilde{\mathbf{E}}$.

- The symbol "$\cong$" means "approximately equal to." This symbol is used when equality exists, but is not being expressed with exact numerical precision. For example, the ratio of the circumference of a circle to its diameter is π, where $\pi \cong 3.14$.
- The symbol "$\approx$" also indicates "approximately equal to," but in this case the two quantities are unequal even if expressed with exact numerical precision. For example, $e^x = 1 + x + x^2/2 + \ldots$ as a infinite series, but $e^x \approx 1 + x$ for $x \ll 1$. Using this approximation $e^{0.1} \approx 1.1$, which is in good agreement with the actual value $e^{0.1} \cong 1.1052$.
- The symbol "$\sim$" indicates "on the order of," which is a relatively weak statement of equality indicating that the indicated quantity is within a factor of 10 or so the indicated value. For example, $\mu \sim 10^5$ for a class of iron alloys, with exact values being being larger or smaller by a factor of 5 or so.
- The symbol "$\triangleq$" means "is defined as" or "is equal as the result of a definition."
- Complex numbers: An italic $j \triangleq \sqrt{-1}$.
