

1.7: Notation

The list below describes notation used in this book.

- **Vectors:** Boldface is used to indicate a vector; e.g., the electric field intensity vector will typically appear as \mathbf{E} . Quantities not in boldface are scalars. When writing by hand, it is common to write “ \vec{E} ” or “ \vec{E} ” in lieu of “ \mathbf{E} .”
- **Unit vectors:** A circumflex is used to indicate a unit vector; i.e., a vector having magnitude equal to one. For example, the unit vector pointing in the $+x$ direction will be indicated as $\hat{\mathbf{x}}$. In discussion, the quantity “ $\hat{\mathbf{x}}$ ” is typically spoken “ x hat.”
- **Time:** The symbol t is used to indicate 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 position in a manner which is independent of a coordinate system; in this case, we typically use the symbol \mathbf{r} . For example, $\mathbf{r} = \hat{\mathbf{x}}x + \hat{\mathbf{y}}y + \hat{\mathbf{z}}z$ in the Cartesian coordinate system.
- **Phasors:** A tilde 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 $\tilde{\mathbf{E}}$.
- **Curves, surfaces, and volumes:** These geometrical entities will usually be indicated in 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:

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

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

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.

- 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, $e^x = 1 + x + x^2/2 + \dots$ as an 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: $j \triangleq \sqrt{-1}$.
- See Appendix C for notation used to identify commonly-used physical constants.

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