

1

Suffix notation and tensor algebra

1.1 Summation convention

We consider a rectangular cartesian coordinate system with unit vectors \mathbf{i} , \mathbf{j} and \mathbf{k} along the three coordinate axes x , y and z respectively. For convenience, we relabel these unit vectors \mathbf{e}_1 , \mathbf{e}_2 and \mathbf{e}_3 and denote the coordinate axes by x_1 , x_2 and x_3 (Figure 1.1). A typical vector \mathbf{a} with components a_1 , a_2 and a_3 in cartesian coordinates can then be written as

$$\mathbf{a} = \sum_{i=1}^3 a_i \mathbf{e}_i. \quad (1.1)$$

Instead of writing the summation sign in (1.1) every time we have an expression of this kind, we can adopt the summation convention: whenever an index occurs precisely twice in a term, it is understood that the index is to be summed over its full range of possible values without the need for explicitly writing the summation sign \sum . Hence (1.1), with this convention, is

$$\mathbf{a} = a_i \mathbf{e}_i, \quad (1.2)$$

where summation over i is implied ($i = 1, 2, 3$). Since the components a_i of \mathbf{a} are given by the dot-product of \mathbf{a} with each of the unit vectors \mathbf{e}_i , then $a_i = \mathbf{a} \cdot \mathbf{e}_i$ ($i = 1, 2, 3$) and (1.2) can be written

$$\mathbf{a} = (\mathbf{a} \cdot \mathbf{e}_i) \mathbf{e}_i, \quad (1.3)$$

again adopting the summation convention.

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Applied Mechanics Reviews, 1950

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