Contents

PART I: ***Mechanics of Rigid Bodies***

Chapter 1

Properties of Forces and Force Systems

COMPONENTS OF A FORCE

The *components* (or *scalar components*) of a force **F** in the x and y directions are denoted by F_x and F_y, respectively (Fig. 1-1), and are

$$F_x = |\mathbf{F}|\cos\theta \qquad F_y = |\mathbf{F}|\sin\theta \tag{1.1}$$

where the vertical bars denote the magnitude of the vector **F**.

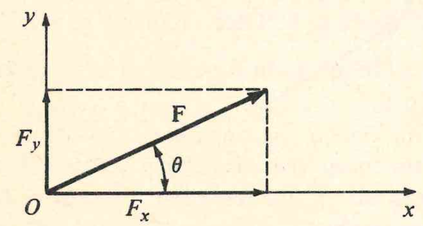

Fig. 1-1

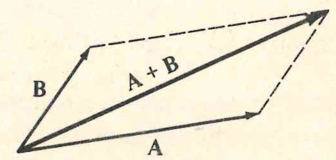

Fig. 1-2

VECTOR ADDITION

Two vectors **A** and **B** may be added by taking **A** and **B** as adjacent sides of a parallelogram, as indicated in Fig. 1-2. The vector sum (or *resultant*) of **A** and **B** is then the vector from the origin of **A** and **B** along the diagonal to the opposite corner. This defines the *parallelogram rule* for vector addition. We sometimes refer to **A** and **B** of Fig. 1-2 as *vector components* of **A** + **B**.

DOT PRODUCT

The *dot product* (or scalar product) of two vectors **A** and **B** is the product of the magnitudes of the two vectors multiplied by the cosine of the acute angle α between them, as shown in Fig. 1-3:

$$\mathbf{A}\cdot\mathbf{B} = |\mathbf{A}||\mathbf{B}|\cos\alpha \tag{1.2}$$

It is frequently convenient to work with unit vectors (i.e., vectors of unit length) directed along the x, y, and z axes, as shown in Fig. 1-4. These are denoted **i**, **j**, and **k**, respectively. From (*1.2*) we obviously have

$$\begin{aligned}\mathbf{i}\cdot\mathbf{i} = \mathbf{j}\cdot\mathbf{j} = \mathbf{k}\cdot\mathbf{k} = 1\\ \mathbf{i}\cdot\mathbf{j} = \mathbf{j}\cdot\mathbf{k} = \mathbf{i}\cdot\mathbf{k} = 0\end{aligned} \tag{1.3}$$

Figure 1-5 shows the extension of these ideas to three-dimensional space.