Definition 1. *Dot product can be defined between two vectors. Suppose two vectors* $\vec{u} = (u_x, u_y, u_z)$ *and* $\vec{v} = (v_x, v_y, v_z)$*. Then*

$$\vec{u} \cdot \vec{v} = u_x v_x + u_y v_y + u_z v_z$$

or

$$\vec{u} \cdot \vec{v} = |\vec{u}||\vec{v}| \cos\theta$$

where θ *is the acute angle between two vectors.*

Property.

$$\vec{u} \cdot \vec{v} = \vec{v} \cdot \vec{u} \tag{1}$$

$$\vec{u} \cdot \vec{v} = 0 \; (\textit{if they are othorgonal}) \tag{2}$$

$$(\vec{u} \cdot \vec{v}) \cdot \vec{w} = \vec{u} \cdot (\vec{v} \cdot \vec{w}) \tag{3}$$

$$\vec{u} \cdot (\vec{v} + \vec{w}) = \vec{u} \cdot \vec{v} + \vec{u} \cdot \vec{v} \tag{4}$$

Note: The result of dot product is a scalar.

Definition 2. *Cross product can be defined between two vectors. Suppose two vectors* $\vec{u} = (u_x, u_y, u_z)$ *and* $\vec{v} = (v_x, v_y, v_z)$*. Then*

$$\vec{u} \times \vec{v} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ u_x & u_y & u_z \\ v_x & v_y & v_z \end{vmatrix}$$

or

$$|\vec{u} \times \vec{v}| = |\vec{u}||\vec{v}| \sin\theta$$

where θ *is the acute angle between two vectors.*

Property.

$$\vec{u} \times \vec{v} = -\vec{v} \times \vec{u} \tag{5}$$

$$\vec{u} \times \vec{v} = 0 \;\; (\textit{if they are parallel}) \tag{6}$$

$$(\vec{u} \times \vec{v}) \times \vec{w} = \vec{u} \times (\vec{v} \times \vec{w}) \tag{7}$$

$$\vec{u} \times (\vec{v} + \vec{w}) = \vec{u} \times \vec{v} + \vec{u} \times \vec{v} \tag{8}$$

$$\tag{9}$$

Note: The result of a cross product is a vector, its direction can be determined by right-hand rule.