

**Problem 12-1)** Define the  $xy$ -plane as the plane of the two vectors  $\mathbf{A}$  and  $\mathbf{B}$ . Each vector has a magnitude and an orientation-angle in the  $xy$ -plane, that is,

$$\mathbf{A} = |\mathbf{A}|(\cos \varphi_A \hat{\mathbf{x}} + \sin \varphi_A \hat{\mathbf{y}}),$$

$$\mathbf{B} = |\mathbf{B}|(\cos \varphi_B \hat{\mathbf{x}} + \sin \varphi_B \hat{\mathbf{y}}).$$

Therefore,

$$\mathbf{A} \cdot \mathbf{B} = A_x B_x + A_y B_y$$

$$= |\mathbf{A}| |\mathbf{B}| (\cos \varphi_A \cos \varphi_B + \sin \varphi_A \sin \varphi_B)$$

$$= |\mathbf{A}| |\mathbf{B}| \cos(\varphi_A - \varphi_B).$$

