CHAPTER - 1
Vector Arithmetic

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1 1.2 POINT VECTORS

1.2.27 In a harbour, wind is blowing at the speed of 72 km/h and the flag on the mast of a boat anchored in the harbour flutters along the N-E direction. If the boat starts moving at a speed of 51 km/h to the north, what is the direction of the flag on the mast of the boat ?

Solution: The wind velocity **w** is blowing at 72 km/h towards the north-east direction. In terms of components, we can write:

$$\mathbf{w} = 72 \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{pmatrix} \tag{1}$$

The boat velocity **b** is moving at 51 km/h towards the north. In vector form, this is:

$$\mathbf{b} = 51 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \tag{2}$$

The wind vector **w** and boat vector **b** are given by:

$$\mathbf{w} = \begin{pmatrix} \frac{72}{\sqrt{2}} \\ \frac{72}{\sqrt{2}} \end{pmatrix} = \begin{pmatrix} 36\sqrt{2} \\ 36\sqrt{2} \end{pmatrix} \tag{3}$$

$$\mathbf{b} = \begin{pmatrix} 0 \\ 51 \end{pmatrix} \tag{4}$$

The resultant vector **v** is calculated as:

$$\mathbf{v} = \mathbf{w} - \mathbf{b} = \begin{pmatrix} 36\sqrt{2} \\ 36\sqrt{2} - 51 \end{pmatrix} \tag{5}$$

The x and y components of **c** are $\mathbf{v_x}$ and $\mathbf{v_y}$ respectively:

$$\mathbf{v_x} = 36\sqrt{2} \tag{6}$$

$$\mathbf{v_y} = 36\sqrt{2} - 51 \tag{7}$$

Let θ be the angle made by **v** with $\mathbf{v_x}$:

$$\tan\theta = \frac{\mathbf{v_y}}{\mathbf{v_x}} \tag{8}$$

$$\tan \theta = \frac{36\sqrt{2} - 51}{36\sqrt{2}} \qquad (9)$$

Thus, the direction of the flag on the mast of the boat is:

$$\theta = \arctan\left(\frac{36\sqrt{2} - 51}{36\sqrt{2}}\right) \qquad (10)$$