LaTeX 11.10.1.7

Lokesh Surana

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CLASS 11, EXERCSE 10.1

Q7. Find the slope of the line, which makes an angle of $30°$ with the positive direction of y-axis measured anticlockwise.

Solution: Direction vector of y-axis is $\mathbf{e}_2 = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ and direction vector of line is $\mathbf{m} = \begin{pmatrix} 1 \\ m \end{pmatrix}$.

$$\cos(30°) = \frac{\mathbf{m}^\top \mathbf{e}_2}{|\mathbf{m}|\,|\mathbf{e}_2|} = \frac{m}{\sqrt{1+m^2}} \tag{1}$$

$$\frac{m}{\sqrt{1+m^2}} = \frac{\sqrt{3}}{2} \tag{2}$$

$$m = \pm\sqrt{3} \tag{3}$$

Let's take the both values of m and verify the result.

Case 1: $m = \sqrt{3}$

$$\frac{\mathbf{m}^T \mathbf{e}_2}{|\mathbf{m}|\,|\mathbf{e}_2|} = \frac{\sqrt{3}}{\sqrt{1+\sqrt{3}^2}} = \frac{\sqrt{3}}{2} \tag{4}$$

$$\implies \frac{\mathbf{m}^T \mathbf{e}_2}{|\mathbf{m}|\,|\mathbf{e}_2|} = \cos(30°) \tag{5}$$

Case 2: $m = -\sqrt{3}$

$$\frac{\mathbf{m}^T \mathbf{e}_2}{|\mathbf{m}|\,|\mathbf{e}_2|} = -\frac{\sqrt{3}}{\sqrt{1+\sqrt{3}^2}} = -\frac{\sqrt{3}}{2} \tag{6}$$

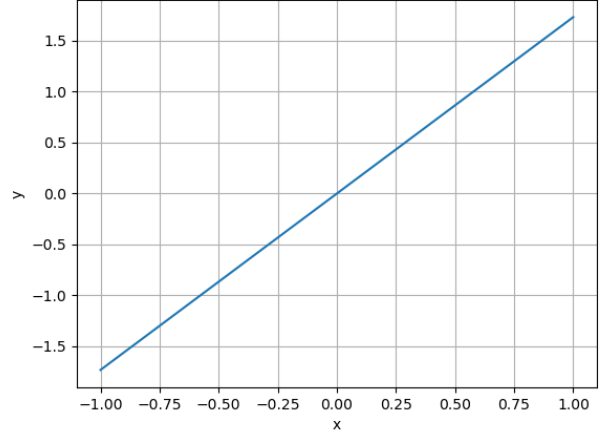$$\implies \frac{\mathbf{m}^T \mathbf{e}_2}{|\mathbf{m}|\,|\mathbf{e}_2|} = -\cos(30°) \tag{7}$$

$$\implies m = \sqrt{3}$$

Fig. 1: Line with slope $m = \sqrt{3}$