Assignment 1

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***Abstract*—This document explains the concept of finding the unit vector making an angle of θ with the positive direction of the x axis.**

Download all python codes from

https://github.com/harshachinta/EE5609−Matrix−Theory/tree/master/Assignments/Assignment%201/code

and latex-tikz codes from

https://github.com/harshachinta/EE5609−Matrix−Theory/tree/master/Assignments/Assignment%201

1 Problem

Write down a unit vector in the xy-plane, making an angle of 30° with the positive direction of the x-axis.

2 Explanation

Unit vector can be found from direction vector which depends on the slope. The slope(m) is given by:

$$m = \tan\theta$$

and the direction vector is obtained from slope as:

$$\begin{pmatrix} 1 \\ m \end{pmatrix}$$

The direction vector of x axis is given by $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ as the slope (m) of x axis is zero.
Now, let us consider a unit vector $\mathbf{a}$ in the xy-plane, and given this vector makes an angle of 30° with the positive direction of the x-axis.
Substituting $\theta = 30°$ in slope equation, we get:

$$m = \tan 30° = \frac{1}{\sqrt{3}}$$

and the direction vector is:

$$\mathbf{a} = \begin{pmatrix} 1 \\ \frac{1}{\sqrt{3}} \end{pmatrix}$$

To find a unit vector with the same direction as direction vector, we divide by the magnitude of the vector.

$$\hat{\mathbf{a}} = \frac{\mathbf{a}}{\|a\|}$$

$$\|a\| = \sqrt{(1)^2 + \left(\frac{1}{\sqrt{3}}\right)^2} = \frac{2}{\sqrt{3}}$$

$\implies$ The unit vector is given by:

$$\hat{\mathbf{a}} = \begin{pmatrix} \frac{1}{\frac{2}{\sqrt{3}}} \\ \frac{\frac{1}{\sqrt{3}}}{\frac{2}{\sqrt{3}}} \end{pmatrix}$$

$$\hat{\mathbf{a}} = \begin{pmatrix} \frac{\sqrt{3}}{2} \\ \frac{1}{2} \end{pmatrix}$$

$$\implies \boxed{\hat{\mathbf{a}} = \begin{pmatrix} \frac{\sqrt{3}}{2} \\ \frac{1}{2} \end{pmatrix}}$$

3 Solution

The unit vector that makes an angle of 30° with the positive direction of the x-axis is:

$$\implies \boxed{\hat{\mathbf{a}} = \begin{pmatrix} \frac{\sqrt{3}}{2} \\ \frac{1}{2} \end{pmatrix}}$$