

# 1-1.11-3

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**Question:** If a line makes  $60^\circ$  and  $45^\circ$  angles with the positive directions of the X-axis and Z-axis respectively, then find the angle that it makes with the positive direction of the Y-axis. Hence, write the direction cosines of the line.

**Solution:** Let  $\alpha$ ,  $\beta$  and  $\gamma$  be the angles made by the line with the X, Y and Z axes respectively. Now the unit direction vector  $\mathbf{x}$  can be expressed as

$$\mathbf{x} = \begin{pmatrix} \cos \alpha \\ \cos \beta \\ \cos \gamma \end{pmatrix}$$

Now, since  $\mathbf{x}$  is a unit vector

$$\begin{aligned} \|\mathbf{x}\| &= 1 \\ \sqrt{\mathbf{x}\mathbf{x}^T} &= 1 \end{aligned}$$

Substituting value of  $\mathbf{x}$

$$\begin{aligned} \cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma &= 1 \\ \frac{1}{4} + \cos^2 \beta + \frac{1}{2} &= 1 \\ \cos^2 \beta &= \frac{1}{4} \\ \beta &= 60^\circ \end{aligned}$$

Hence the direction cosines are

$$\mathbf{x} = \begin{pmatrix} \cos \alpha \\ \cos \beta \\ \cos \gamma \end{pmatrix} = \begin{pmatrix} \cos 60^\circ \\ \cos 60^\circ \\ \cos 45^\circ \end{pmatrix} = \begin{pmatrix} \frac{1}{2} \\ \frac{1}{2} \\ \frac{1}{\sqrt{2}} \end{pmatrix}$$

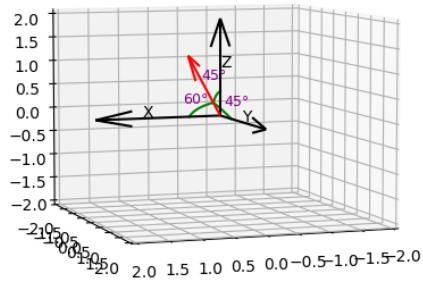


Fig. 0: Plot of the described vector

Code for this plot can be found at:

```
Codes/main.py  
Codes/main.c
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