

# Matgeo Presentation - Problem 1.11.6-

ai25btech11004 - Jaswanth

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## Question

Find the direct cosines of a line which makes equal angles with the coordinate axes.

## Solution

Let  $\theta$  be the angle made by a line with coordinate axes. The direction cosines of line  $l$  are given by  $\begin{pmatrix} \cos \theta \\ \cos \theta \\ \cos \theta \end{pmatrix}$

Since  $||l|| = 1$ , we have

$$\cos^2 \theta + \cos^2 \theta + \cos^2 \theta = 1 \quad (0.1)$$

$$3 \cos^2 \theta = 1 \quad \Rightarrow \quad \cos^2 \theta = \frac{1}{3} \quad (0.2)$$

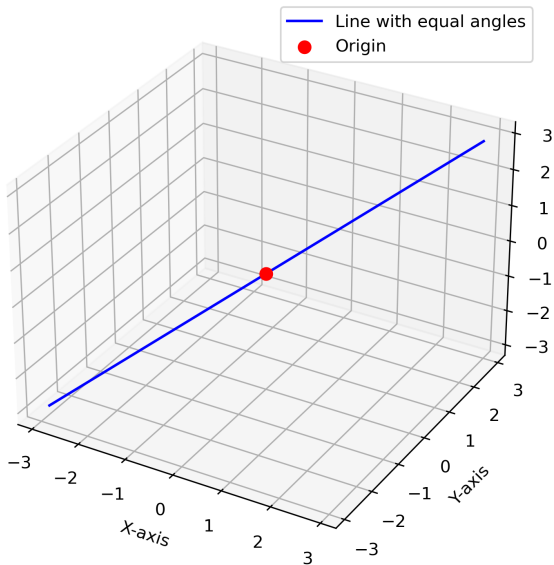
Since  $\theta$  is an acute angle,

$$\cos \theta = \frac{1}{\sqrt{3}} \quad (0.3)$$

Hence, direction cosines of a line are  $\begin{pmatrix} \frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} \end{pmatrix}$

# Plot

Line making equal angles with coordinate axes



# C Code: Vector.c

```
#include <stdio.h>
#include <math.h>

int main() {
    FILE *fp;
    fp = fopen("axis.dat", "w"); // Open file to write

    if (fp == NULL) {
        printf("Error opening file!\n");
        return 1;
    }

    // Since line makes equal angles with coordinate axes
    // direction cosines are 1/sqrt(3)
    double val = 1.0 / sqrt(3.0);

    fprintf(fp, "Direction cosines of a line making equal angles with coordinate axes:\n");
    fprintf(fp, "Possible sets are:\n\n");

    // There are 8 possible combinations of signs
    int signs[8][3] = {
        { 1, 1, 1},
        { 1, 1, -1},
        { 1, -1, 1},
        { 1, -1, -1},
        {-1, 1, 1},
        {-1, 1, -1},
        {-1, -1, 1},
        {-1, -1, -1}
    };

    for (int i = 0; i < 8; i++) {
        fprintf(fp, "(%.4f, %.4f, %.4f)\n",
```

## C Code: Vector.c

```
        signs[i][0] * val,  
        signs[i][1] * val,  
        signs[i][2] * val);  
    }  
  
    fclose(fp);  
    printf("Direction cosines written to axis.dat successfully.\n");  
    return 0;  
}
```

# Python: plot.py

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

# Direction cosines
l = m = n = 1/np.sqrt(3)

# Define line points
t = np.linspace(-5, 5, 100)
x = l * t
y = m * t
z = n * t

# Plotting
fig = plt.figure(figsize=(8, 6))
ax = fig.add_subplot(111, projection='3d')

# Plot the line
ax.plot(x, y, z, label="Line with equal angles", color="blue")

# Plot origin
ax.scatter(0, 0, 0, color="red", s=50, label="Origin")

# Axes labels
ax.set_xlabel('X-axis')
ax.set_ylabel('Y-axis')
ax.set_zlabel('Z-axis')
ax.set_title("Line making equal angles with coordinate axes")
ax.legend()

# Save the figure
plt.savefig("equal_angles_line.png", dpi=300, bbox_inches='tight')

# Show the plot
plt.show()
```