MatGeo Assignment 4.4.3

AI25BTECH11007

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Question

Equation of the line passing through the origin and making 30° , 60°, and 90° with the X, Y, Z axes respectively is.

Solution

The line makes angles of $30^\circ, 60^\circ, 90^\circ$ with the X, Y, Z axes respectively.

Hence the direction cosines are:

$$\begin{pmatrix} \cos 30^\circ \\ \cos 60^\circ \\ \cos 90^\circ \end{pmatrix} = \begin{pmatrix} \frac{\sqrt{3}}{2} \\ \frac{1}{2} \\ 0 \end{pmatrix}$$

let the direction vector be:

$$\mathbf{d} = \begin{pmatrix} \sqrt{3} \\ 1 \\ 0 \end{pmatrix}.$$

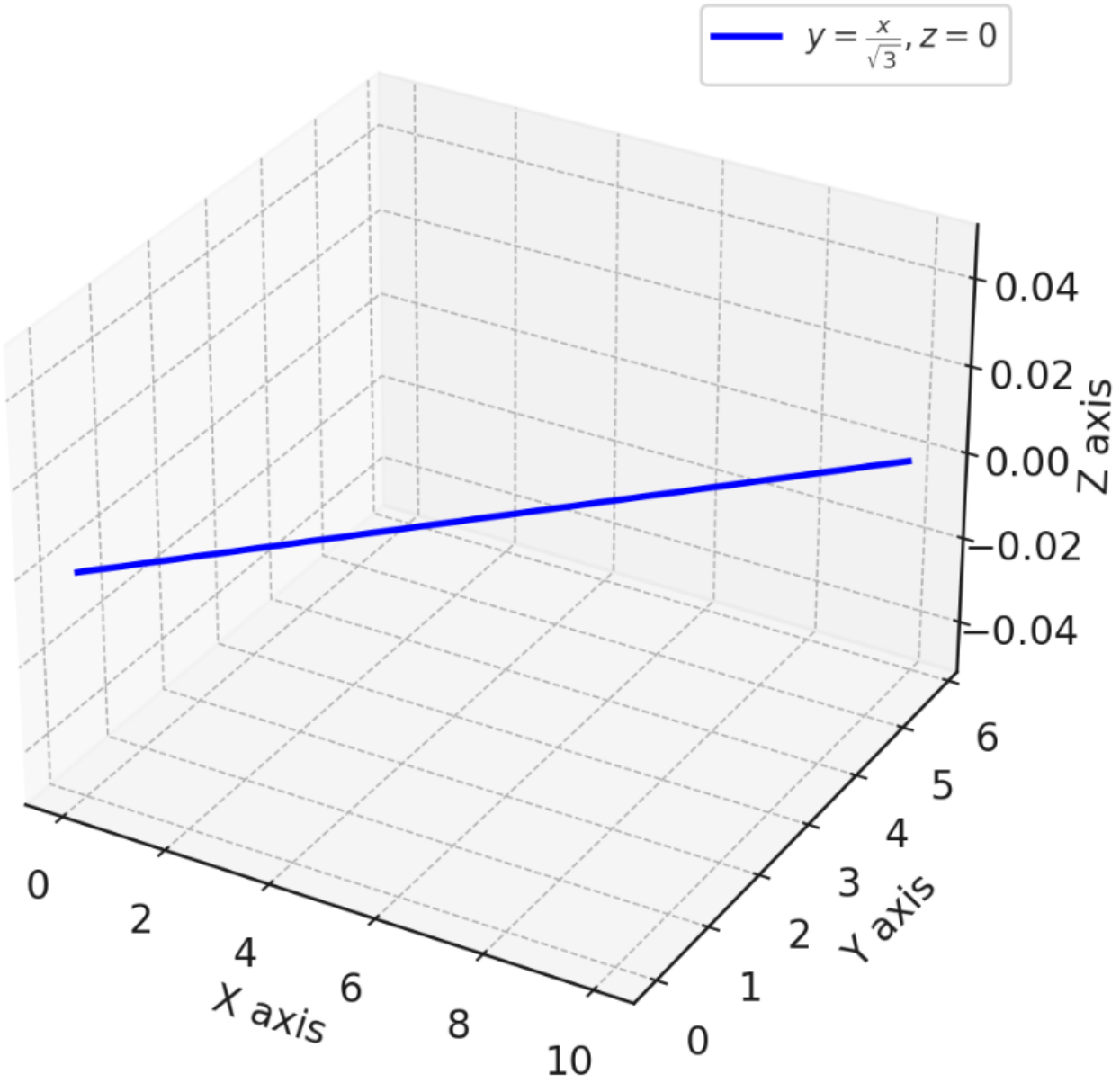
Since the line passes through the origin $\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$, any point $\mathbf{r}$ on the line is given in parametric form as:

$$\mathbf{r}(t) = \mathbf{r}_0 + t\mathbf{d} = t \begin{pmatrix} \sqrt{3} \\ 1 \\ 0 \end{pmatrix}, \quad t \in \mathbb{R}.$$

Thus, the parametric equations of the line are:

$$\boxed{x = \sqrt{3}t, \quad y = t, \quad z = 0.}$$

Plot


$y = \frac{x}{\sqrt{3}}, z = 0$
0.04
0.02
0.00
−0.02
−0.04
Z axis
0
2
4
6
8
10
X axis
0
1
2
3
4
5
6
Y axis

C code

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

int main() {
    // Angles in degrees
    double alpha = 30.0, beta = 60.0, gamma = 90.0;

    // Direction cosines
    double lx = cos(alpha * M_PI / 180.0);
    double ly = cos(beta * M_PI / 180.0);
    double lz = cos(gamma * M_PI / 180.0);

    printf("Direction cosines:\n");
    printf("cos(30) = %.3f\n", lx);
    printf("cos(60) = %.3f\n", ly);
    printf("cos(90) = %.3f\n", lz);
```

C code

```c
// Equation of line through origin: (x/lx) = (y/ly) = (z/lz)
printf("\nEquation of line:\n");
printf("y = x / sqrt(3), z = 0\n");

    // Verify with some values of x
    printf("\nSample points on the line:\n");
    for (int x = 0; x <= 6; x += 2) {
        double y = x / sqrt(3);
        double z = 0;
        printf("(%.2f, %.2f, %.2f)\n", (double)x, y, z);
    }

    return 0;
}
```

Python Code

```
    import numpy as np
import matplotlib.pyplot as plt

# Angles in degrees
alpha, beta, gamma = 30, 60, 90

# Direction cosines
lx = np.cos(np.radians(alpha))
ly = np.cos(np.radians(beta))
lz = np.cos(np.radians(gamma))

print("Direction cosines:")
print(f"cos(30Âř) = {lx:.3f}")
print(f"cos(60Âř) = {ly:.3f}")
print(f"cos(90Âř) = {lz:.3f}")

print("\nEquation of the line:")
print("y = x / sqrt(3), z = 0")
```

Python Code

```
x_vals = np.linspace(0, 10, 6)
y_vals = x_vals / np.sqrt(3)
z_vals = np.zeros_like(x_vals)
print("\nSample points on the line:")
for x, y, z in zip(x_vals, y_vals, z_vals):
    print(f"({x:.2f}, {y:.2f}, {z:.2f})")
# Plot the line in 3D
fig = plt.figure(figsize=(8,6))
ax = fig.add_subplot(111, projection='3d')
ax.plot(x_vals, y_vals, z_vals, label=r'$y = \frac{x}{\sqrt{3}},
    z=0$', color='blue', linewidth=2)

ax.set_xlabel('X axis')
ax.set_ylabel('Y axis')
ax.set_zlabel('Z axis')
ax.set_title('Line through origin making 30Âř, 60Âř, 90Âř with X,
     Y, Z axes')
ax.legend()
plt.show()
```