4.3.41

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Question

The cartesian equation of a line is $\frac{x-5}{3} = \frac{y+4}{7} = \frac{z-6}{2}$. Write its vector form.

Given Information

Given cartesian equation of line is

$$\frac{x-5}{3} = \frac{y+4}{7} = \frac{z-6}{2} = \lambda \tag{1}$$

We know the vector form of a line is given by,

$$\mathbf{x} = \mathbf{h} + k\mathbf{m} \tag{2}$$

Solution

Where **x** is a point on the given line, **h** is a known point on that line, **m** is the slope of the line and k is an arbitrary real constant.

From 1, we can determine a point on the line taking $\lambda = 0$

$$\frac{x-5}{3} = \frac{y+4}{7} = \frac{z-6}{2} = 0 \implies x = 5, y = -4, z = 6 \tag{3}$$

$$\implies \mathbf{h} = \begin{pmatrix} 5 \\ -4 \\ 6 \end{pmatrix} \tag{4}$$

Final Answer

We can get the ratio of direction cosines from 1

$$\text{ratio} = 3:7:2 \implies \mathbf{m} = \begin{pmatrix} 3 \\ 7 \\ 2 \end{pmatrix} \tag{5}$$

Substituting 4 and 5 in 2, we get

$$\mathbf{x} = \begin{pmatrix} 3 \\ -4 \\ 6 \end{pmatrix} + k \begin{pmatrix} 3 \\ 7 \\ 2 \end{pmatrix} \tag{6}$$

Python code

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


t = np.linspace(-10, 10, 100)

m = np.array([3, 7, 2], dtype=np.float64)
x = 5 + t * m[0]
y = -4 + t * m[1]
z = 6 + t * m[2]


fig = plt.figure()
ax = plt.subplot(111, projection='3d')
```

Python code

```
ax.plot(x, y, z, label='3D Line', color='blue')
ax.scatter(5, -4, 6, color='red', label='Point (5, -4, 6)')


ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.legend()
ax.set_title('3D Line from Vector Equation')
```

Python code

```
plt.savefig('/home/shreyas/GVV_Assignments/matgeo/4.3.41/figs/
    fig1.png')
plt.show()
```

3D Plot

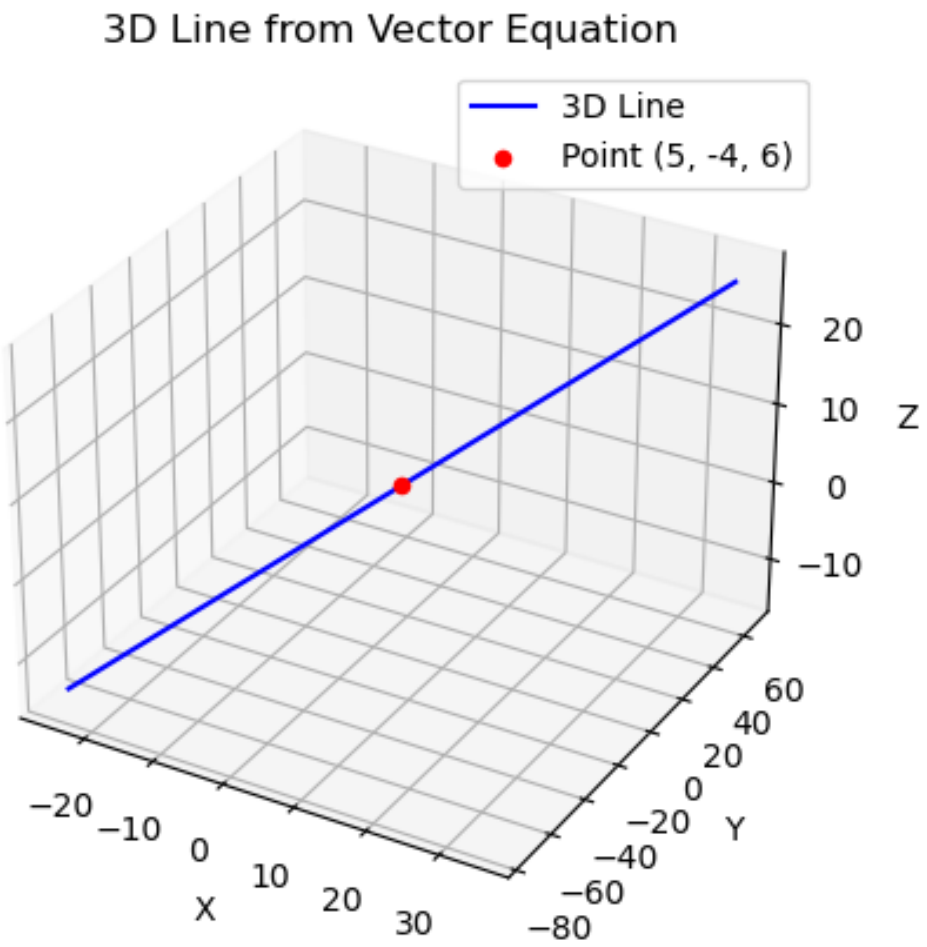

Figure: 3D Plot