4.5.14

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Question

Find the equation of the line through the point $(5, 2, -4)$ and which is parallel to the vector $3\hat{i} + 2\hat{j} - 8\hat{k}$.

given data

Line is:	**vector**
parallel to	$\begin{pmatrix} 3 \\ 2 \\ -8 \end{pmatrix}$
Passing through	$\begin{pmatrix} 5 \\ 2 \\ -4 \end{pmatrix}$

Table: 4.5.14

Formula

If the direction vector of the line is $\mathbf{A}$ and is passing through $\mathbf{B}$ then,

Equation of the line is: $\mathbf{X} = \mathbf{B} + \lambda\mathbf{A}$

finding the equation of line:

Given,

$$\text{The line is parallel to the vector } \begin{pmatrix} 3 \\ 2 \\ -8 \end{pmatrix} \tag{1}$$

$$\therefore \text{Direction vector is: } \lambda \begin{pmatrix} 3 \\ 2 \\ -8 \end{pmatrix} \tag{2}$$

Equation of the line :-

$$\mathbf{x} = \begin{pmatrix} 5 \\ 2 \\ -4 \end{pmatrix} + \lambda \begin{pmatrix} 3 \\ 2 \\ -8 \end{pmatrix} \tag{3}$$

Where,

$$\mathbf{x} = \begin{pmatrix} \mathbf{x} \\ \mathbf{y} \\ \mathbf{z} \end{pmatrix} \tag{4}$$

Hence, Equation of the line passing through $\begin{pmatrix} 5 \\ 2 \\ -4 \end{pmatrix}$ and Parallel to $\begin{pmatrix} 3 \\ 2 \\ -8 \end{pmatrix}$ is:

$$\mathbf{x} = \begin{pmatrix} 5 \\ 2 \\ -4 \end{pmatrix} + \lambda \begin{pmatrix} 3 \\ 2 \\ -8 \end{pmatrix}$$

Python Code

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

# Point the line passes through
point = np.array([5, 2, -4])
# Direction vector
direction = np.array([3, 2, -8])

# Parameter t
t = np.linspace(-5, 5, 100)
```

Python Code

```
# Parametric equations of the line
x = point[0] + direction[0] * t
y = point[1] + direction[1] * t
z = point[2] + direction[2] * t

# Create the figure
fig = plt.figure(figsize=(8, 6))
ax = fig.add_subplot(111, projection='3d')
# Plot the line
ax.plot(x, y, z, color='blue', label='Line through (5,2,-4)
    parallel to (3,2,-8)')
```

Python Code

```
# Highlight the given point
ax.scatter(point[0], point[1], point[2], color='red', s=50, label
    ='Point (5,2,-4)')

# Axis labels and title
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_title('3D Line Plot')
ax.legend()

plt.show()
```

C Code

```c
#include <stdio.h>

int main() {
    // Point through which the line passes
    double x0 = 5, y0 = 2, z0 = -4;
    // Direction vector
    double a = 3, b = 2, c = -8;

    printf("The vector equation of the line is:\n");
    printf("r = (%.1f, %.1f, %.1f) + t(%.1f, %.1f, %.1f)\n", x0,
        y0, z0, a, b, c);
```

C Code

```
    printf("\nParametric form:\n");
    printf("x = %.1f + %.1f t\n", x0, a);
    printf("y = %.1f + %.1f t\n", y0, b);
    printf("z = %.1f + %.1f t\n", z0, c);

    return 0;
}
```

Python and C Code

```
import subprocess
import os

# Determine the executable name based on the operating system
executable_name = 'line_program'
if os.name == 'nt': # 'nt' is the name for Windows
    executable_name += '.exe'
# Prepend './' to specify the current directory
executable_path = os.path.join('.', executable_name)
```

Python and C Code

```
# Run the C program as a subprocess
# capture_output=True saves its output
# text=True decodes the output as text
# check=True raises an error if the C program fails
result = subprocess.run(
    [executable_path],
    capture_output=True,
    text=True,
    check=True
)
# Print the output that was captured from the C program
print(result.stdout)
```

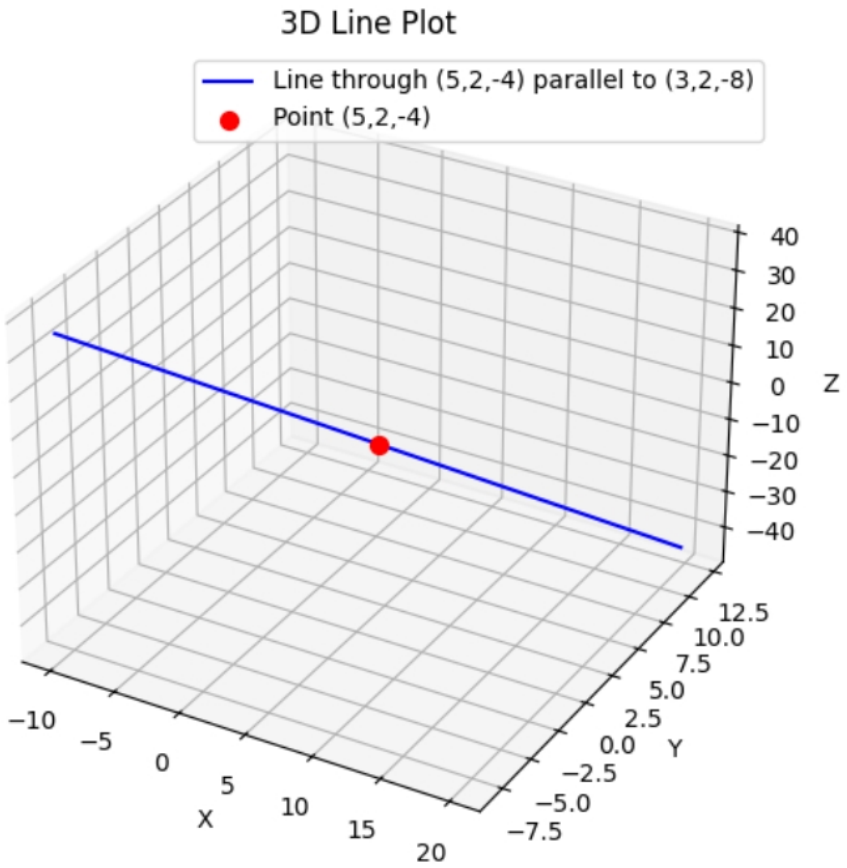
3D Line Plot
Line through (5,2,-4) parallel to (3,2,-8)
Point (5,2,-4)
40
30
20
10
0
−10
−20
−30
−40
Z
12.5
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
Y
−10
−5
0
5
10
15
20
X

Figure: Plot