

1-1.6.29

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# Question

Show that the points  $A(2, 3, -4)$ ,  $B(1, -2, 3)$  and  $C(3, 8, -11)$  are collinear.

# Solution

Given,

$$A = \begin{pmatrix} 2 \\ 3 \\ -4 \end{pmatrix}, B = \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}, C = \begin{pmatrix} 3 \\ 8 \\ -11 \end{pmatrix}$$

For Points **A**, **B**, **C** to be collinear if

$$\text{rank} (\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A}) \quad (1)$$

$$\mathbf{B} - \mathbf{A} = \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix} - \begin{pmatrix} 2 \\ 3 \\ -4 \end{pmatrix} \quad (2)$$

$$= \begin{pmatrix} -1 \\ -5 \\ 7 \end{pmatrix} \quad (3)$$

$$\mathbf{C} - \mathbf{A} = \begin{pmatrix} 3 \\ 8 \\ -11 \end{pmatrix} - \begin{pmatrix} 2 \\ 3 \\ -4 \end{pmatrix} \quad (4)$$

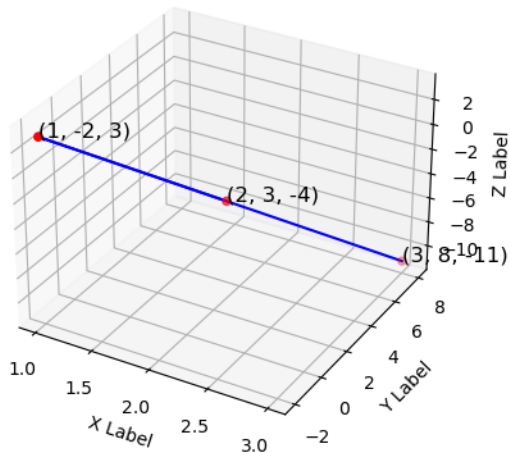
$$= \begin{pmatrix} 1 \\ 5 \\ -7 \end{pmatrix} \quad (5)$$

$$\text{Rank}(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A}) = \begin{pmatrix} -1 & 1 \\ -5 & 5 \\ 7 & -7 \end{pmatrix} \quad (6)$$

$$\text{rank} \begin{pmatrix} -1 & 1 \\ -5 & 5 \\ 7 & -7 \end{pmatrix} = 1 \quad (7)$$

Since, the rank of  $(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A}) = 1$ . Therefore,  $\mathbf{A} = \begin{pmatrix} 2 \\ 3 \\ -4 \end{pmatrix}$ ,  $\mathbf{B} = \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}$ ,  $\mathbf{C} = \begin{pmatrix} 3 \\ 8 \\ -11 \end{pmatrix}$  are collinear.

# Figure



```
from ctypes import *
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

# Load the shared object file
collinear_lib = CDLL('./collinear.so')

# Define the Point3D structure
class Point3D(Structure):
    _fields_ = [("x", c_int), ("y", c_int), ("z", c_int)]

# Define the argument and return types of the C function
collinear_lib.areCollinear.argtypes = [POINTER(Point3D), POINTER(
    Point3D), POINTER(Point3D)]
collinear_lib.areCollinear.restype = c_int
```

```
def check_collinearity(p1, p2, p3):  
    return collinear_lib.areCollinear(byref(p1), byref(p2), byref(p3))  
  
# Define three 3D points  
point1 = Point3D(2, 3, -4)  
point2 = Point3D(1, -2, 3)  
point3 = Point3D(3, 8, -11)  
  
# Check if they are collinear  
collinear = check_collinearity(point1, point2, point3)  
  
# Print result  
if collinear:  
    print("The points are collinear.")
```



```
else:
    print("The points are not collinear.")

# Visualization
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')

# Plot points
ax.scatter([point1.x, point2.x, point3.x],
           [point1.y, point2.y, point3.y],
           [point1.z, point2.z, point3.z], color='r')

# Add labels for each point
ax.text(point1.x, point1.y, point1.z, "(2, 3, -4)", color='black', fontsize
        =12)
```

# Python Code IV

```
ax.text(point2.x, point2.y, point2.z, "(1, -2, 3)", color='black', fontsize
        =12)
ax.text(point3.x, point3.y, point3.z, "(3, 8, -11)", color='black', fontsize
        =12)

# Plot lines between points for better visualization
ax.plot([point1.x, point2.x], [point1.y, point2.y], [point1.z, point2.z], color
        ='b')
ax.plot([point2.x, point3.x], [point2.y, point3.y], [point2.z, point3.z], color
        ='b')

# Labels
ax.set_xlabel('X Label')
ax.set_ylabel('Y Label')
ax.set_zlabel('Z Label')
```

# Python Code V

```
plt.savefig("fig_1.png")  
plt.show()
```

```
#include <stdio.h>
#include "collinear.c"
int areCollinear(Point3D* p1, Point3D* p2, Point3D* p3);
int main() {
    Point3D p1 = {2, 3, -4};
    Point3D p2 = {1, -2, 3};
    Point3D p3 = {3, 8, -11};

    if (areCollinear(&p1, &p2, &p3)) {
        printf("The points are collinear.\n");
    } else {
        printf("The points are not collinear.\n");
    }

    return 0;
}
```