# 2.10.48

EE25BTECH11019 - Darji Vivek M.

# Question

If $\mathbf{a} = \mathbf{i} + \mathbf{j} + \mathbf{k}$, $\mathbf{a} \cdot \mathbf{b} = 1$ and $\mathbf{a} \times \mathbf{b} = \mathbf{j} - \mathbf{k}$, then $\mathbf{b}$ is 2

- $\mathbf{i} - \mathbf{j} + \mathbf{k}$
- $2\mathbf{j} - \mathbf{k}$
- $\mathbf{i}$
- $2\mathbf{i}$

# Solution

$$\mathbf{a} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}, \quad \mathbf{b} = \begin{pmatrix} x \\ y \\ z \end{pmatrix} \tag{1}$$

Dot product condition:

$$x + y + z = 1$$

# Solution

Cross product condition gives

$$z - y = 0, \quad x - z = 1, \quad y - x = -1$$

The first equation can be expressed as

$$\begin{pmatrix} 0 & 1 & -1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = 0$$

# Solution

Collecting all equations:

$$\begin{pmatrix} 0 & 1 & -1 \\ 1 & 0 & -1 \\ 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix}$$

Solving,

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

# Final Answer

Hence,

$$\mathbf{b} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} = \mathbf{i}$$

Therefore, the correct option is **(c)**.

# Answer

$$\mathbf{b} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} = \mathbf{i}$$

$\therefore$ Correct option: (c)

# C Code

```c
// Function to compute b given a b and a b
#include <stdio.h>
#include <math.h>

void find_b(double *b) {
    double a[3] = {1, 1, 1};
    double dot = 1;
    double cross[3] = {0, 1, -1};

    b[0] = 1; // x
    b[1] = 0; // y
    b[2] = 0; // z
}
```

# C Code

```c
int main() {
    double b[3];
    find_b(b);
    FILE *file = fopen("values.dat", "w");
    fprintf(file, "b_x\tb_y\tb_z\n");
    fprintf(file, "%.2lf\t%.2lf\t%.2lf\n", b[0], b[1],
        b[2]);
    fclose(file);
    printf("Vector b written: (%.2lf, %.2lf, %.2lf)\n"
        , b[0], b[1], b[2]);
    return 0;
}
```

# Python Plot

```
1  import ctypes
2  import numpy as np
3  import matplotlib.pyplot as plt
4
5  lib = ctypes.CDLL('./libb.so')
6  b = (ctypes.c_double * 3)()
7  lib.find_b(b)
8
9  bx, by, bz = b[0], b[1], b[2]
10 print(f"Vector b = ({bx}, {by}, {bz})")
11
12 a = np.array([1, 1, 1])
13 b_vec = np.array([bx, by, bz])
14 O = np.array([0, 0, 0])
```

# Python plot

```
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.quiver(0,0,0, a[0],a[1],a[2], color='r', label='a = i+j+k')
ax.quiver(0,0,0, b_vec[0],b_vec[1],b_vec[2], color='b', label='b')
points = {'O':0,'A (1,1,1)':a,f'B ({bx:.0f},{by:.0f},{bz:.0f})':b_vec}
for label, coord in points.items():
    ax.text(coord[0], coord[1], coord[2], f'{label}',
        fontsize=10, ha='center')
ax.set_xlim([0, 2]); ax.set_ylim([0, 2]); ax.set_zlim([0, 2])
ax.set_xlabel('X'); ax.set_ylabel('Y'); ax.set_zlabel('Z')
ax.legend(); plt.title("Vectors a and b with coordinates")
plt.show()
```

# plot

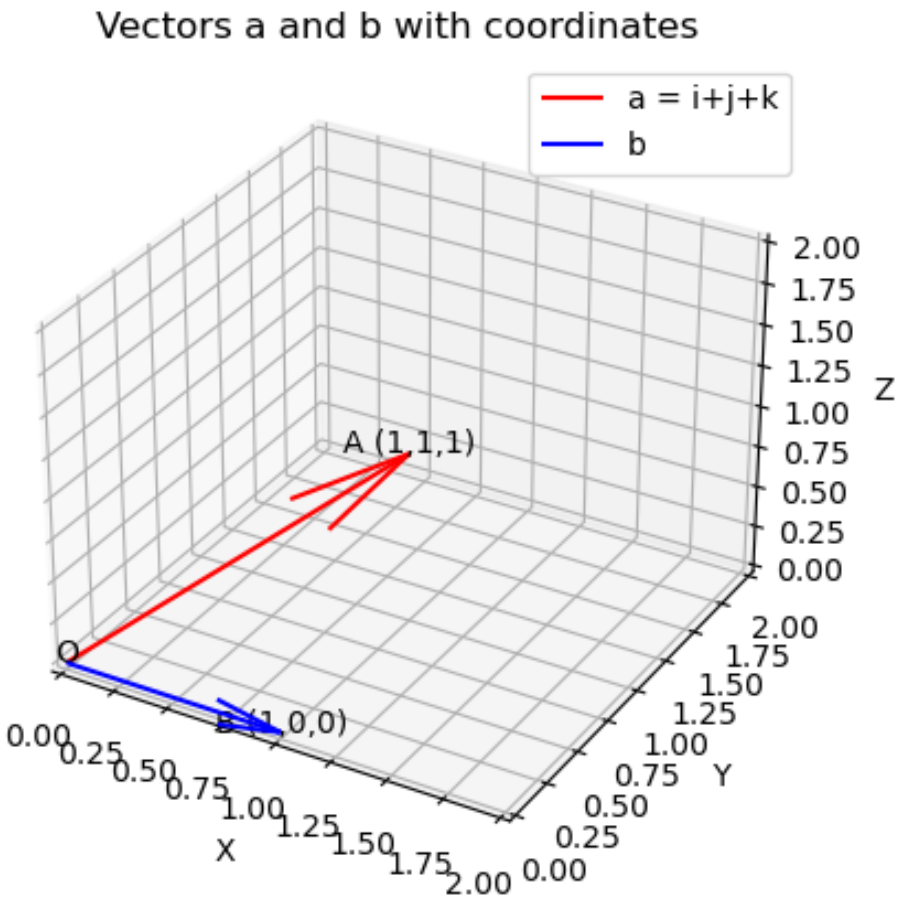


Figure: plot