

1.6.17

AI25BTECH11002 - Ayush Sunil Labhade

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Question:

Using vectors, find the value of k such that the points $(k, -10, 3)$, $\mathbf{B}(1, -1, 3)$ and $(3, 5, 3)$ are collinear.

Solution: Given:

Point	Vector
a	$\begin{pmatrix} k \\ -10 \\ 3 \end{pmatrix}$
b	$\begin{pmatrix} 1 \\ -1 \\ 3 \end{pmatrix}$
c	$\begin{pmatrix} 3 \\ 5 \\ 3 \end{pmatrix}$

Table: Given data

Since the points are collinear, we can use

$$\text{rank}(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{B}) = 1 \quad (0.1)$$

Therefore,

$$(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{B})^T = \begin{pmatrix} 1 - k & 3 - 1 \\ -1 - (-10) & 5 - (-1) \\ 3 - 3 & 3 - 3 \end{pmatrix} \quad (0.2)$$

$$\begin{pmatrix} 1 - k & 2 \\ 9 & 6 \\ 0 & 0 \end{pmatrix} \xrightarrow{R_2 \leftrightarrow R_1} \begin{pmatrix} 9 & 6 \\ 1 - k & 2 \\ 0 & 0 \end{pmatrix} \quad (0.3)$$

$$\begin{pmatrix} 9 & 6 \\ 1 - k & 2 \\ 0 & 0 \end{pmatrix} \xrightarrow{R_2 = R_2 - \frac{1/3}{R_1}} \begin{pmatrix} 9 & 6 \\ -k - 2 & 0 \\ 0 & 0 \end{pmatrix} \quad (0.4)$$

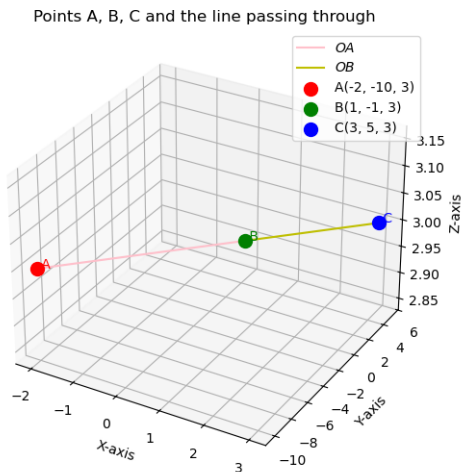
The rank of the matrix will be 1 when

$$-k - 2 = 0 \quad (0.5)$$

$$\Rightarrow k = -2$$

(0.6)

Graph:



Therefore, $k = -2$.