

## 1.5.13

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# Question

Find the ratio in which the Y-axis divides the line segment joining the points **A**(5, −6) and **B**(−1, −4). Also find the coordinates of the point of intersection.

# Equation

Let the Y-axis divide the line segment  $\mathbf{B} - \mathbf{A}$  at point  $\mathbf{C}$  in the ratio  $m : 1$ .  
Since  $\mathbf{C}$  lies on Y-axis, let

$$\mathbf{C} = \begin{pmatrix} 0 \\ y \end{pmatrix}$$

The point  $\mathbf{A}$ ,  $\mathbf{B}$ ,  $\mathbf{C}$  are collinear.

$$\implies \text{rank} \begin{pmatrix} \mathbf{B} - \mathbf{A} & \mathbf{C} - \mathbf{A} \end{pmatrix} = 1 \quad (1)$$

# Theoretical Solution

$$\begin{pmatrix} -6 & -5 \\ 2 & a+6 \end{pmatrix} \Rightarrow R_2 \rightarrow \frac{1}{3}R_1 + R_2 \begin{pmatrix} -6 & -5 \\ 0 & a + \frac{13}{3} \end{pmatrix} \quad (2)$$

The number of nonzero rows in the row reduced matrix (also known as *echelon form*) is defined as the rank. For above matrix to be of rank 1,

$$a + \frac{13}{3} = 0 \quad (3)$$

$$a = \frac{-13}{3} \quad (4)$$

$\therefore$  The coordinates of the point of intersection are

$$\mathbf{C} = \begin{pmatrix} 0 \\ \frac{-13}{3} \end{pmatrix}$$

# Theoretical Solution

Substituting the values of **A**, **B** and **C**,

$$k = \frac{\begin{pmatrix} 5 & -\frac{5}{3} \end{pmatrix} \begin{pmatrix} 1 \\ -\frac{1}{3} \end{pmatrix}}{\left\| \begin{pmatrix} 1 \\ -\frac{1}{3} \end{pmatrix} \right\|^2} = 5 \quad (5)$$

Thus, the ratio in which the point **C** divides the line segment **B – A** is **5:1**.

```
#include <stdio.h>
#include <math.h>
void function(double *P, double *B, double *A , int m, int k) {
    for ( int i = 0 ; i < m ; i++ ) {
        P[i] = (1*A[i] + k*B[i])/(k+1) ;
    }
}
```

```
import sys
import math
import numpy as np
import matplotlib.pyplot as plt
import ctypes

problem = ctypes.CDLL('/home/ganachari-vishwmabhar/ee1030-2025/
EE25BTECH11025/ASSIGNMENTS/matgeo/1.5.13/codes/problem.so')
```

```
problem.argtypes = [  
    ctypes.POINTER(ctypes.c_double),  
    ctypes.POINTER(ctypes.c_double),  
    ctypes.POINTER(ctypes.c_double),  
    ctypes.c_int,  
    ctypes.c_int,  
]  
problem.restype = None # void function  
  
m = 2  
k = 5  
  
A = np.array([[5, -6]], dtype=np.float64)  
B = np.array([[-1, -4]], dtype=np.float64)  
P = np.zeros(m, dtype=np.float64)
```



```
problem.function(  
    P.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    B.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    A.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    m, #len(P) alternate  
    k  
)  
  
A = np.array([5, -6]).reshape(-1,1)  
B = np.array([-1, -4]).reshape(-1,1)  
P = P.reshape(-1,1)
```

```
plt.plot([A[0,0], B[0,0]], [A[1,0], B[1,0]], 'g--', label="Line  
Segment AB")

plot_coords = np.block([[A, B, P]])
plt.scatter(plot_coords[0,:], plot_coords[1,:], color='blue')

vert_labels = [
    f'A({A[0,0]}, {A[1,0]})',
    f'B({B[0,0]}, {B[1,0]})',
    f'P({P[0,0]}, {P[1,0]:.2f})'
]
```

```
for i, txt in enumerate(vert_labels):
    plt.annotate(txt,
                  (plot_coords[0,i],plot_coords[1,i]),
                  textcoords="offset points",
                  xytext=(0,10),
                  ha='center')

plt.xlabel('$x$')
plt.ylabel('$y$')
plt.title("Line Segment AB Divided by Y-axis")
plt.legend(loc='best')
plt.grid()
plt.axis('equal')

plt.savefig("../figs/plot.png")
plt.show()
```

# Plot

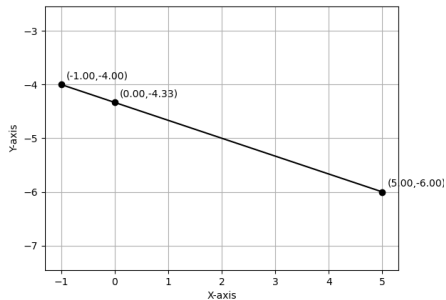


Figure: Plot of Intersection of AB by Y-axis