

# Matgeo Presentation - Problem 1.6.6

ee25btech11056 - Suraj.N

August 24, 2025

# Problem Statement

In each of the following, find the value of  $k$  for which the points are collinear:

(a)  $(7, -2)$ ,  $(5, 1)$ ,  $(3, k)$

(b)  $(8, 1)$ ,  $(k, -4)$ ,  $(2, -5)$

# Method

## Condition for Collinearity:

Three points  $A, B, C$  are collinear iff the collinearity matrix

$$M = (\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A})^{\top}$$

has  $\text{rank}(M) = 1$ .

## Part (a) Matrix

$$(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A})^{\top} = \begin{pmatrix} -2 & 3 \\ -4 & k+2 \end{pmatrix}$$

$$\begin{pmatrix} -2 & 3 \\ -4 & k+2 \end{pmatrix} \xleftrightarrow{R_2=R_2-2R_1} \begin{pmatrix} -2 & 3 \\ 0 & k-4 \end{pmatrix}$$

For collinearity,  $\text{rank}(M) = 1 \iff k - 4 = 0 \implies \boxed{k = 4}$ .

## Part (b) Matrix

$$(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A})^{\top} = \begin{pmatrix} k-8 & -5 \\ -6 & -6 \end{pmatrix}$$

$$\begin{pmatrix} k-8 & -5 \\ -6 & -6 \end{pmatrix} \xleftrightarrow{R_2 = (k-8)R_2 + 6R_1} \begin{pmatrix} k-8 & -5 \\ 0 & 18-6k \end{pmatrix}$$

For collinearity,  $\text{rank}(M) = 1 \iff 18 - 6k = 0 \implies \boxed{k = 3}$ .

# Final Answer

(a)  $k = 4$

(b)  $k = 3$

# Plots

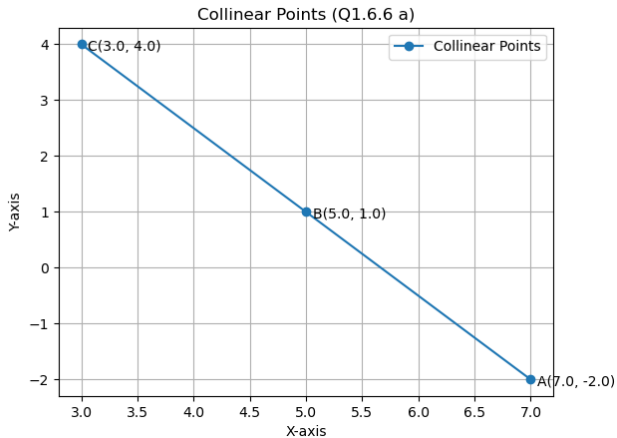


Fig 1 : Line through the given points

# Plots

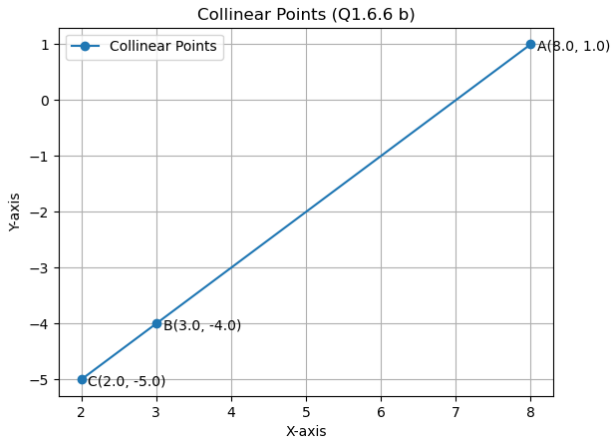


Fig 2 : Line through the given points



## C Code: points.c (Part 1)

```
#include <stdio.h>

int main() {
    FILE *fp;

    // Question 1.6.6 (a)
    int k_a = 4; // Final answer
    printf("Q1.6.6(a): k_a=%d\n", k_a);

    fp = fopen("points_a.dat", "w");
    fprintf(fp, "%d,%d,%d\n", 7, -2, 0); // A
    fprintf(fp, "%d,%d,%d\n", 5, 1, 0); // B
    fprintf(fp, "%d,%d,%d\n", 3, k_a, 0); // C
    fclose(fp);
}
```

## C Code: points.c (Part 2)

```
// Question 1.6.6 (b)
int k_b = 3; // Final answer
printf("Q1.6.6(b): k_b=%d\n", k_b);

fp = fopen("points_b.dat", "w");
fprintf(fp, "%d,%d,%d\n", 8, 1, 0); // A
fprintf(fp, "%d,%d,%d\n", k_b, -4, 0); // B
fprintf(fp, "%d,%d,%d\n", 2, -5, 0); // C
fclose(fp);

return 0;
}
```

# Python: call\_c.py

```
import subprocess

# Compile the C program
subprocess.run(["gcc", "points.c", "-o", "points"], check=True)

# Run the compiled C program
result = subprocess.run(
    ["./points"], capture_output=True, text=True, check=True
)

# Print the output from the C program
print(result.stdout)
```

# Python: plot.py (Part 1)

```
import numpy as np
import matplotlib.pyplot as plt

def plot_points(filename, labels, title, output_file):
    points = np.loadtxt(filename, delimiter=',', usecols=(0,1))
    x = points[:,0]
    y = points[:,1]

    plt.plot(x, y, 'o-', label='Collinear_Points')

    for i, txt in enumerate(labels):
        plt.annotate(f"{txt}-{tuple(points[i])}", (x[i], y[i]),
                    xytext=(5,-5), textcoords="offset_points")
```

## Python: plot.py (Part 2)

```
plt.xlabel("X-axis")
plt.ylabel("Y-axis")
plt.title(title)
plt.legend()
plt.grid(True)

plt.savefig(output_file)
print(f"Saved figure as {output_file}")
plt.close()
```

*# Part (a)*

```
plot_points("points_a.dat", ["A","B","C"],
            "Collinear_Points_Q1.6.6_a", "fig_a.png")
```

*# Part (b)*

```
plot_points("points_b.dat", ["A","B","C"],
            "Collinear_Points_Q1.6.6_b", "fig_b.png")
```