

## MatGeo Presentation - Problem 5.2.66

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## Question

Solve the system of equations and hence find the value of  $m$  which satisfies

$$2x + 3y = 11 \quad (0.1)$$

$$2x + 4y = -24 \quad (0.2)$$

$$y = mx + 3 \quad (0.3)$$

## Solution

→ We have

$$\mathbf{n}_1^T \mathbf{x} = c_1$$

$$\mathbf{n}_2^T \mathbf{x} = c_2$$

$$\mathbf{n}_1 = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$$

$$c_1 = 11 \quad (0.4)$$

$$\mathbf{n}_2 = \begin{pmatrix} 2 \\ 4 \end{pmatrix}$$

$$c_2 = -24 \quad (0.5)$$

→ To solve the given system of equations

$$\begin{pmatrix} \mathbf{n}_1^T \\ \mathbf{n}_2^T \end{pmatrix} \mathbf{x} = \begin{pmatrix} c_1 \\ c_2 \end{pmatrix} \implies \begin{pmatrix} 2 & 3 \\ 2 & 4 \end{pmatrix} \mathbf{x} = \begin{pmatrix} 11 \\ -24 \end{pmatrix} \quad (0.6)$$

→ Using augmented matrix

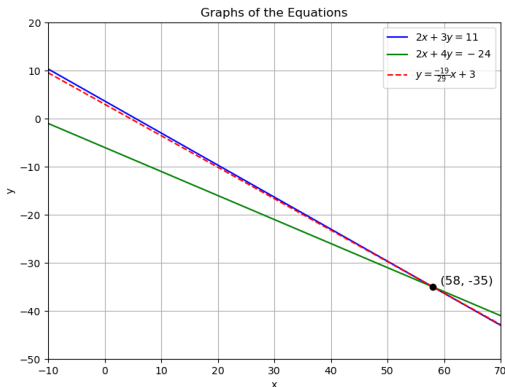
$$\left( \begin{array}{cc|c} 2 & 3 & 11 \\ 2 & 4 & -24 \end{array} \right) \xrightarrow[R_1 \leftrightarrow R_1 - 3R_2]{R_2 \leftrightarrow R_2 - R_1} \left( \begin{array}{cc|c} 2 & 0 & 116 \\ 0 & 1 & -35 \end{array} \right) \quad (0.7)$$

$$\xrightarrow{R_1 \leftrightarrow (1/2)R_1} \left( \begin{array}{cc|c} 1 & 0 & 58 \\ 0 & 1 & -35 \end{array} \right) \quad (0.8)$$

# Solution

$$\Rightarrow \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 58 \\ -35 \end{pmatrix} \Rightarrow x = 58 \text{ and } y = -35 \quad (0.9)$$

From (3) and (9),  $m = \frac{y-3}{x} = -\frac{19}{29}$  (0.10)



## File: plot.py

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

# Define the x range
x_vals = np.linspace(-10, 70, 400)

# Equation 1:  $2x + 3y = 11 \rightarrow y = (11 - 2x) / 3$ 
y1_vals = (11 - 2 * x_vals) / 3

# Equation 2:  $2x + 4y = -24 \rightarrow y = (-24 - 2x) / 4$ 
y2_vals = (-24 - 2 * x_vals) / 4

# Line  $y = mx + 3$  where  $m = -19/29$ 
m = -19 / 29
y3_vals = m * x_vals + 3

# Plotting
plt.figure(figsize=(8, 6))

# Plot the lines
plt.plot(x_vals, y1_vals, label=r'$2x_{\text{}}+3y_{\text{}}=11$', color='blue')
plt.plot(x_vals, y2_vals, label=r'$2x_{\text{}}+4y_{\text{}}=-24$', color='green')
plt.plot(x_vals, y3_vals, label=r'$y_{\text{}}=\frac{-19}{29}x_{\text{}}+3$', color='red', linestyle='dashed')
```

## File: plot.py

```
# Mark the point (58, -35)
plt.scatter(58, -35, color='black', zorder=5)
plt.text(58, -35, f' $(58, -35)$ ', fontsize=12, verticalalignment='bottom')

# Set labels and title
plt.xlabel('x')
plt.ylabel('y')
plt.title('Graphs of the Equations')

# Show legend
plt.legend()

# Set axis limits for better viewing
plt.xlim(-10, 70)
plt.ylim(-50, 20)

# Show grid
plt.grid(True)

# Show plot
plt.show()
```