5.2.30

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Question

Solve the following system of linear equations.

$$7x - 15y = 2$$
$$x + 2y = 3$$

Equation I

The given equation can be written as:

$$\begin{pmatrix} 7 & -15 \\ 1 & 2 \end{pmatrix} \mathbf{x} = \begin{pmatrix} 2 \\ 3 \end{pmatrix} \tag{1}$$

Theoretical Solution

$$\left(\begin{array}{cc|c} 7 & -15 & 2 \\ 1 & 2 & 3 \end{array}\right) \xleftrightarrow{R_2 \leftarrow R_2 - \frac{1}{7} R_1} \left(\begin{array}{cc|c} 7 & -15 & 2 \\ 0 & \frac{29}{7} & \frac{19}{7} \end{array}\right) \tag{2}$$

$$\left(\begin{array}{cc|c} 7 & -15 & 2 \\ 0 & \frac{29}{7} & \frac{19}{7} \end{array}\right) \xleftrightarrow[R_1 \leftarrow \frac{1}{7} R_1]{R_2 \leftarrow \frac{7}{29} R_2} \left(\begin{array}{cc|c} 1 & \frac{-15}{7} & \frac{2}{7} \\ 0 & 1 & \frac{19}{29} \end{array}\right) \tag{3}$$

$$\left(\begin{array}{cc|c} 1 & \frac{-15}{7} & \frac{2}{7} \\ 0 & 1 & \frac{19}{29} \end{array}\right) \xleftrightarrow{R_1 \leftarrow R_1 + \frac{15}{7}} \left(\begin{array}{cc|c} 1 & 0 & \frac{49}{29} \\ 0 & 1 & \frac{19}{29} \end{array}\right) \tag{4}$$

From this we can say that:

$$\mathbf{x} = \begin{pmatrix} \frac{49}{29} \\ \\ \frac{19}{29} \end{pmatrix} \tag{5}$$

C Code

```c
#include <stdio.h>

void solve_system(double a1, double b1, double c1, double a2,
    double b2, double c2, double *x_sol, double *y_sol) {
    // Calculate the determinant of the coefficient matrix
    double determinant = a1 * b2 - a2 * b1;

    // Check for a unique solution
    if (determinant != 0) {
        *x_sol = (c1 * b2 - c2 * b1) / determinant;
        *y_sol = (a1 * c2 - a2 * c1) / determinant;
    } else {
        // Handle the case of no unique solution (parallel or
            coincident lines)
        // For this problem, we assume a unique solution exists.
        *x_sol = 0.0;
        *y_sol = 0.0;
    }
```

C Code

```
  / Main function for standalone testing in C
int main() {
    double x, y;

    // Solve: 7x - 15y = 2 and x + 2y = 3
    solve_system(7.0, -15.0, 2.0, 1.0, 2.0, 3.0, &x, &y);

    printf(Solution from C:\n);
    printf(x = %f\n, x);
    printf(y = %f\n, y);

    return 0;
}
```

Python Code

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

# --- 1. Solve the system using the C library ---

# Load the shared library
    # Assumes the compiled library is in the same directory
c_lib = ctypes.CDLL('./intersection.so')


# Define the function signature to match the C function
solve_system_c = c_lib.solve_system
```

Python Code

```
    solve_system_c.argtypes = [ctypes.c_double, ctypes.c_double, ctypes.c_double,
                               ctypes.c_double, ctypes.c_double, ctypes.c_double,
                               ctypes.POINTER(ctypes.c_double),
                               ctypes.POINTER(ctypes.c_double)]
solve_system_c.restype = None

# Create C-compatible double variables to store the results
x_sol = ctypes.c_double()
y_sol = ctypes.c_double()

# Call the C function with the coefficients
solve_system_c(7.0, -15.0, 2.0, 1.0, 2.0, 3.0, ctypes.byref(x_sol), ctypes.byref(y_sol))
```

Python Code

```
# Get the Python values from the C types
x_intersect = x_sol.value
y_intersect = y_sol.value

print(fSolution from C via Python: x = {x_intersect}, y = {y_intersect})

# --- 2. Plot the graph ---

# Generate a range of x values around the intersection point
x_vals = np.linspace(x_intersect - 2, x_intersect + 2, 400)

# Calculate y values for each equation
# Eq1: 7x - 15y = 2 => y = (7x - 2) / 15
y1_vals = (7 * x_vals - 2) / 15
# Eq2: x + 2y = 3 => y = (3 - x) / 2
y2_vals = (3 - x_vals) / 2
```

Python Code

```python
# Create the plot
plt.figure(figsize=(8, 7))
plt.plot(x_vals, y1_vals, label='7x - 15y = 2', color='blue')
plt.plot(x_vals, y2_vals, label='x + 2y = 3', color='green')

# Mark and label the intersection point
plt.plot(x_intersect, y_intersect, 'ro', markersize=8, label=f'
    Intersection ({x_intersect:.2f}, {y_intersect:.2f})')
plt.text(x_intersect + 0.1, y_intersect, f'({x_intersect:.2f}, {
    y_intersect:.2f})', fontsize=12)
```

Python Code

```
# Style the plot
plt.title('Figure')
plt.xlabel('X-axis')
plt.ylabel('Y-axis')
plt.axhline(0, color='black', linewidth=0.5)
plt.axvline(0, color='black', linewidth=0.5)
plt.grid(True, which='both', linestyle='--', linewidth=0.5)
plt.legend()
plt.axis('equal')
plt.savefig(/media/indhiresh-s/New Volume/Matrix/ee1030-2025/
    ee25btech11027/MATGEO/5.2.30/figs/figure1.png)
plt.show()
```

Plot

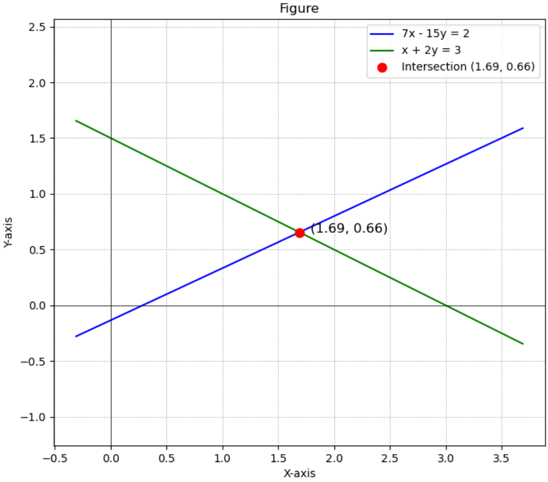

Figure
7x - 15y = 2
x + 2y = 3
Intersection (1.69, 0.66)
(1.69, 0.66)
Y-axis
X-axis
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5