Matgeo Presentation - Problem 4.7.45

Revanth Siva Kumar.D – EE25BTECH11048

September 29, 2025

QUESTION

The equation of the line passing through the point $(1, 2)$ and perpendicular to the line $x + y + 1 = 0$ is

Solution:

Let desired line :

$$\mathbf{n}^T\mathbf{x} = c \tag{0.1}$$

Given line equation and point say A:

$$x + y + 1 = 0 \tag{0.2}$$

$$y = -x - 1 \tag{0.3}$$

$$\mathbf{A} = \begin{pmatrix} 1 \\ 2 \end{pmatrix} \tag{0.4}$$

Since, the line from eq (0.2) is perpendicular to (0.1)
We get the normal vector which is equal to:

$$\mathbf{n} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \tag{0.5}$$

Because line (0.2) is perpendicular, the equation of the line can be changed as:

$$\mathbf{n}^T\left(\mathbf{x} - \mathbf{A}\right) = 0 \tag{0.6}$$

Solution:

Thus the equation of line:

$$\begin{pmatrix} 1 & -1 \end{pmatrix} \left(\mathbf{x} - \begin{pmatrix} 1 \\ 2 \end{pmatrix} \right) = 0 \tag{0.7}$$

$$\implies \begin{pmatrix} 1 & -1 \end{pmatrix} \mathbf{x} - \begin{pmatrix} 1 & -1 \end{pmatrix} \begin{pmatrix} 1 \\ 2 \end{pmatrix} = 0 \tag{0.8}$$

$$\implies \begin{pmatrix} 1 & -1 \end{pmatrix} \mathbf{x} = -1 \tag{0.9}$$

Final Answer The desired line equation is as follows

$$\begin{pmatrix} 1 & -1 \end{pmatrix} \mathbf{x} = -1$$

C Source Code: points.c

```c
#include <stdio.h>

// Compute slope of required line
double compute_slope() {
    // Given line: x + y + 1 = 0  slope = -1
    double slope_given = -1.0;

    // Required line  given line  slope = -1 / slope_given
    double slope_required = -1.0 / slope_given;

    return slope_required; // should be 1.0
}
```

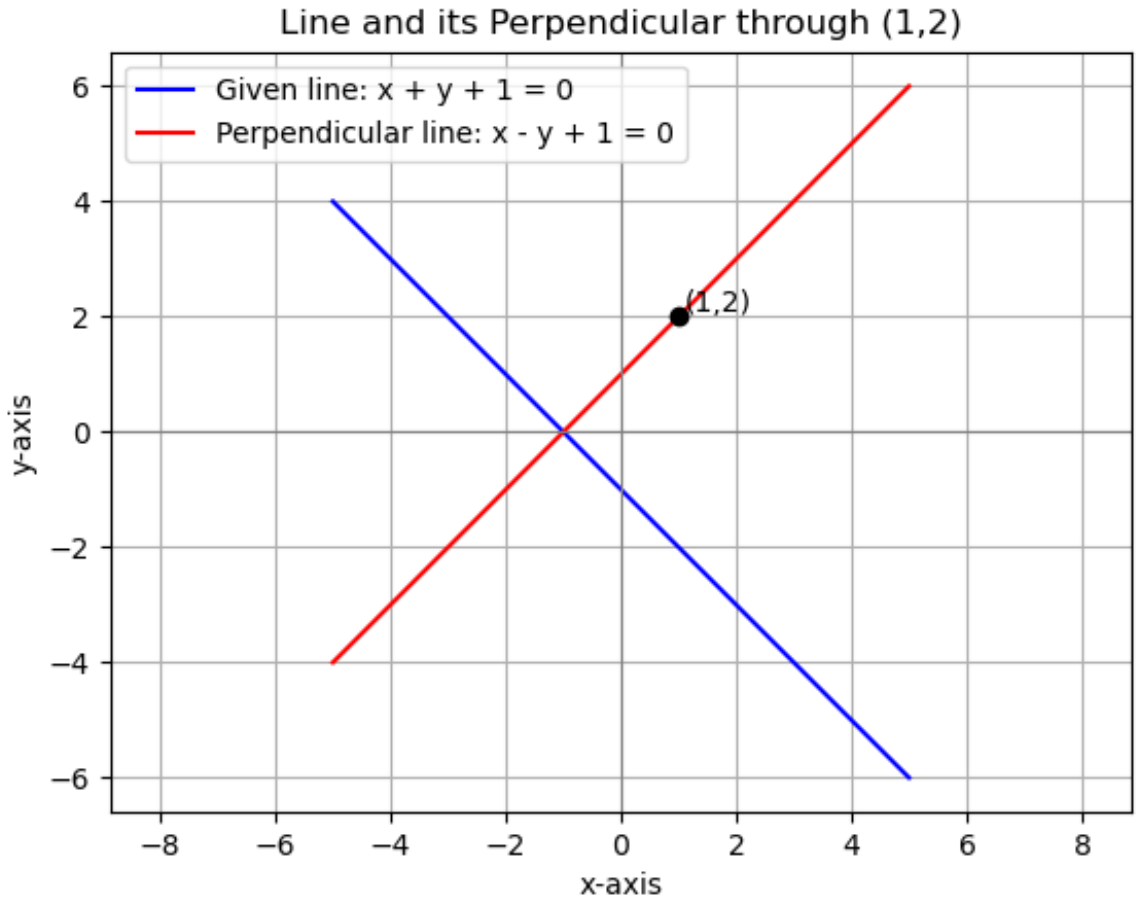
Python Script: call c.py

```
import ctypes
import numpy as np

# Load shared library
lib = ctypes.CDLL("./points.so")

# Prepare array for slopes
slopes = (ctypes.c_double * 2)()
lib.compute_slopes(slopes)

slope_given = slopes[0]
slope_perp = slopes[1]

# Known point
x0, y0 = 1, 2

# Equation form: y = mx + c
def line_eqn(m, x0, y0):
    c = y0 - m * x0
    return m, c

m1, c1 = line_eqn(slope_given, x0, y0)
m2, c2 = line_eqn(slope_perp, x0, y0)

print("Given␣line:␣␣␣␣␣␣␣␣y␣=", m1, "x␣+", c1)
print("Perpendicular␣line:␣y␣=", m2, "x␣+", c2)
```

Python Script: plot.py

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

# Given line: x + y + 1 = 0
# Perpendicular line through (1,2): slope = 1 => equation: x - y + 1 = 0

# Define range for x
x = np.linspace(-5, 5, 400)

# Equations of lines
y_given = -x - 1 # x + y + 1 = 0
y_perp = x + 1 # x - y + 1 = 0

# Plot given line
plt.plot(x, y_given, 'b', label="Given line: x + y + 1 = 0")

# Plot perpendicular line
plt.plot(x, y_perp, 'r', label="Perpendicular line: x - y + 1 = 0")
# Plot the point (1,2)
plt.scatter(1, 2, color='k', zorder=5)
plt.text(1.1, 2.1, "(1,2)", fontsize=10)
# Add axes
plt.axhline(0, color='gray', linewidth=0.8)
plt.axvline(0, color='gray', linewidth=0.8)
# Title and labels
plt.title("Line and its Perpendicular through (1,2)")
plt.xlabel("x-axis")
plt.ylabel("y-axis")
plt.legend()
plt.grid(True)
plt.axis('equal')
plt.show()
```

Result Plot



Triangle ABC plotted using shared output