

4.2.16

EE25BTECH11018 - Darisy Sreetej

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Question

Point $P(0, 2)$ is the point of intersection of the y-axis and the perpendicular bisector of the line segment joining the points $A(-1, 1)$ and $B(3, 3)$.

True or False

Table:

A	$\begin{pmatrix} -1 \\ 1 \end{pmatrix}$
B	$\begin{pmatrix} 3 \\ 3 \end{pmatrix}$

Obtaining the perpendicular bisector

Let the equation of perpendicular bisector be

$$\mathbf{n}^T \mathbf{x} = C \quad (1)$$

Let \mathbf{R} be the midpoint of the line segment \mathbf{AB}

$$\mathbf{R} = \frac{\mathbf{A} + \mathbf{B}}{2} = \frac{\begin{pmatrix} -1 \\ 1 \end{pmatrix} + \begin{pmatrix} 3 \\ 3 \end{pmatrix}}{2} \quad (2)$$

$$\mathbf{R} = \begin{pmatrix} 1 \\ 2 \end{pmatrix} \quad (3)$$

The direction vector of \mathbf{AB} is

$$\mathbf{n} = \mathbf{B} - \mathbf{A} = \begin{pmatrix} 4 \\ 2 \end{pmatrix} \quad (4)$$

As it passes through the midpoint **R** ,

$$\begin{pmatrix} 4 & 2 \end{pmatrix} \begin{pmatrix} 1 \\ 2 \end{pmatrix} = C \quad (5)$$

$$C = 8 \quad (6)$$

Therefore , the equation of the perpendicular bisector is

$$\begin{pmatrix} 4 \\ 2 \end{pmatrix}^T \mathbf{x} = 8 \quad (7)$$

$$\begin{pmatrix} 2 \\ 1 \end{pmatrix}^T \mathbf{x} = 4 \quad (8)$$

Obtaining point of intersection

Let **P** be the point of intersection of y-axis with the perpendicular bisector
Intersection with y-axis ($x = 0$) ,

$$\begin{pmatrix} 2 & 1 \end{pmatrix} \begin{pmatrix} 0 \\ y \end{pmatrix} = 4 \quad (9)$$

$$y = 4 \quad (10)$$

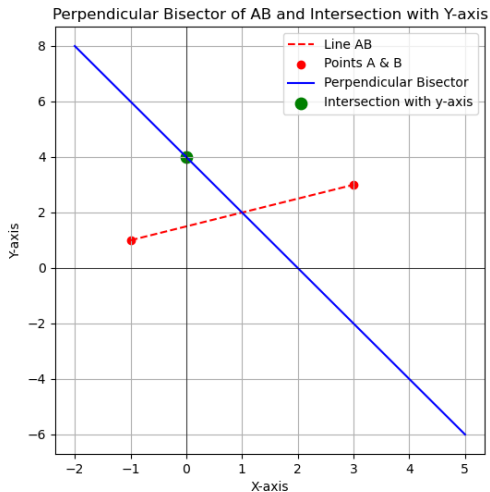
Thus,

$$P = \begin{pmatrix} 0 \\ 4 \end{pmatrix} \quad (11)$$

The point of intersection is $P(0, 4)$

Conclusion

Therefore the Statement is **False**



C code

```
#include <stdio.h>

// Function to calculate midpoint of AB
void midpoint(float Ax, float Ay, float Bx, float By, float *Mx,
             float *My) {
    *Mx = (Ax + Bx) / 2.0;
    *My = (Ay + By) / 2.0;
}

// Function to calculate direction vector (B - A)
void direction(float Ax, float Ay, float Bx, float By, float *dx,
              float *dy) {
    *dx = Bx - Ax;
    *dy = By - Ay;
}

// Function to calculate perpendicular bisector equation
coefficients
```

C Code

```
// Returns c value; coeff[0] = a, coeff[1] = b
float perpendicularBisector(float Ax, float Ay, float Bx, float
    By, float coeff[2]) {
    float Mx, My, dx, dy;

    midpoint(Ax, Ay, Bx, By, &Mx, &My);
    direction(Ax, Ay, Bx, By, &dx, &dy);
    coeff[0] = dx;
    coeff[1] = dy;
    return (coeff[0] * Mx + coeff[1] * My);
}

// Function to find intersection with y-axis (x = 0)
float intersectionY(float coeff[2], float c) {
    // Equation:  $a \cdot 0 + b \cdot y = c$   $y = c/b$ 
    return c / coeff[1];
}
```

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

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

# Argument and return types
lib.perpendicularBisector.argtypes = [ctypes.c_float, ctypes.c_float,
                                       ctypes.c_float, ctypes.c_float,
                                       ctypes.POINTER(ctypes.c_float)]
lib.perpendicularBisector.restype = ctypes.c_float
```

```
lib.intersectionY.argtypes = [ctypes.POINTER(ctypes.c_float),
    ctypes.c_float]
lib.intersectionY.restype = ctypes.c_float

# Input points
Ax, Ay = -1.0, 1.0
Bx, By = 3.0, 3.0

# Prepare coeff array (a,b)
coeff = (ctypes.c_float * 2)()
c = lib.perpendicularBisector(Ax, Ay, Bx, By, coeff)

a, b = coeff[0], coeff[1]
print(f"Equation: {a:.1f}x + {b:.1f}y = {c:.1f}")

# Intersection with y-axis
y_inter = lib.intersectionY(coeff, c)
print(f"Intersection with y-axis: (0, {y_inter:.1f})")
```

Python + C code

```
# Plotting
# Original line AB
x_vals = np.array([Ax, Bx])
y_vals = np.array([Ay, By])

# Perpendicular bisector line:  $ax + by = c \rightarrow y = (c - a*x)/b$ 
x_line = np.linspace(-2, 5, 100)
y_line = (c - a * x_line) / b

plt.figure(figsize=(6,6))
plt.plot(x_vals, y_vals, 'r--', label="Line AB")
plt.scatter([Ax, Bx], [Ay, By], color='red', label="Points A & B"
)

plt.plot(x_line, y_line, 'b-', label="Perpendicular Bisector")
plt.scatter([0], [y_inter], color='green', s=80, label="
Intersection with y-axis")

plt.axhline(0, color='black', linewidth=0.5)
```

```
plt.axvline(0, color='black', linewidth=0.5)

plt.legend()
plt.grid(True)
plt.xlabel("X-axis")
plt.ylabel("Y-axis")
plt.title("Perpendicular Bisector of AB and Intersection with Y-
axis")
plt.show()
```

Python code

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

# Input points
Ax, Ay = -1, 1
Bx, By = 3, 3

# Midpoint
Mx, My = (Ax + Bx) / 2, (Ay + By) / 2

# Direction vector of AB
dx, dy = Bx - Ax, By - Ay

# Equation of perpendicular bisector:  $a*x + b*y = c$ 
a, b = dx, dy
c = a*Mx + b*My

# Intersection with y-axis (x=0)
y_inter = c / b
```

Python code

```
print(f"Equation of perpendicular bisector: {a}x + {b}y = {c}")
print(f"Intersection with y-axis: (0, {y_inter})")

# Line AB
x_AB = [Ax, Bx]
y_AB = [Ay, By]

# Perpendicular bisector line
x_line = np.linspace(-2, 5, 100)
y_line = (c - a*x_line) / b

plt.figure(figsize=(6,6))
plt.plot(x_AB, y_AB, 'r--', label="Line AB")
plt.scatter([Ax, Bx], [Ay, By], color='red', label="Points A & B"
)

plt.plot(x_line, y_line, 'b-', label="Perpendicular Bisector")
plt.scatter([0], [y_inter], color='green', s=80, label="
Intersection with y-axis")
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plt.axhline(0, color='black', linewidth=0.5)
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