

Assignment-4

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Download all python codes from

<https://github.com/unnatigupta2320/Assignment-4/tree/master/CODES>

and latex-tikz codes from

<https://github.com/unnatigupta2320/Assignment-4>

1 QUESTION NO. 2.17

Find the perpendicular distance of the following lines from the origin and angle between the perpendicular and positive x-axis.

- $(1 - \sqrt{3})\mathbf{x} = -8$
- $(0 \ 1)\mathbf{x} = 2$
- $(1 - 1)\mathbf{x} = 4$

2 SOLUTION

1) For finding the perpendicular distance of lines from origin:

- Let a point $\mathbf{A} = \begin{pmatrix} x_1 \\ y_1 \end{pmatrix}$.
- The perpendicular distance of a point \mathbf{A} from a line $ax+by+c=0$ is given by:-

$$d = \frac{|a(x_1) + b(y_1) + c|}{\|\mathbf{n}\|} \quad (2.0.1)$$

$$\text{where, } \mathbf{n} = \begin{pmatrix} a \\ b \end{pmatrix} \quad (2.0.2)$$

- If the point is $\mathbf{O} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$, then

$$d = \frac{|a(0) + b(0) + c|}{\|\mathbf{n}\|} \quad (2.0.3)$$

$$d = \frac{|c|}{\|\mathbf{n}\|} \quad (2.0.4)$$

2) For finding angle between the perpendicular and positive x-axis:-

- We have:

$$ax + by + c = 0 \quad (2.0.5)$$

$$by = -ax - c \quad (2.0.6)$$

$$y = \frac{-a}{b}x - \frac{c}{b} \quad (2.0.7)$$

- So, the slope, m_1 can be written as:

$$m_1 = \frac{-a}{b} \quad (2.0.8)$$

- Let slope of the perpendicular line = m_2 , then we know that:

$$m_1 \times m_2 = -1 \quad (2.0.9)$$

$$m_2 = \frac{-1}{m_1} \quad (2.0.10)$$

- Using (2.0.8) in above equation we get:

$$m_2 = \frac{b}{a} \quad (2.0.11)$$

$$m_2 = \tan \theta \quad (2.0.12)$$

$$\theta = \tan^{-1}(m_2) \quad (2.0.13)$$

3) For line, $(1 - \sqrt{3})\mathbf{x} = -8$

- We have:

$$c = 8, \mathbf{n} = \begin{pmatrix} 1 \\ -\sqrt{3} \end{pmatrix} \quad (2.0.14)$$

- Using (2.0.4) we get:

$$d = \frac{|c|}{\|\mathbf{n}\|} \quad (2.0.15)$$

$$d = \frac{8}{\sqrt{1+3}} \quad (2.0.16)$$

$$d = \frac{8}{2} = 4 \text{ units} \quad (2.0.17)$$

- Using (2.0.11) the slope of the line perpendicular to given line is:

$$m_2 = \frac{b}{a} \quad (2.0.18)$$

$$m_2 = \frac{-\sqrt{3}}{1} = -\sqrt{3} \quad (2.0.19)$$

- Also, Using (2.0.13) the angle between Perpendicular and Positive x-axis is:

$$\theta = \tan^{-1}(m_2) \quad (2.0.20)$$

$$\theta = \tan^{-1}(-\sqrt{3}) (\because m_2 = -\sqrt{3}) \quad (2.0.21)$$

$$\theta = -60^\circ \quad (2.0.22)$$

4) For line, $(0 \ 1)\mathbf{x} = 2$

- We have:

$$c = 2, \mathbf{n} = \begin{pmatrix} 0 \\ 1 \end{pmatrix} \quad (2.0.23)$$

- Using (2.0.4) we get:

$$d = \frac{|c|}{\|\mathbf{n}\|} \quad (2.0.24)$$

$$d = \frac{2}{\sqrt{1}} \quad (2.0.25)$$

$$d = 2 \text{ units} \quad (2.0.26)$$

- Using (2.0.11), the slope of the line perpendicular to given line is:

$$m_2 = \frac{b}{a} \quad (2.0.27)$$

$$\text{But as } a = 0 \implies m_2 = \infty \quad (2.0.28)$$

- The angle between Perpendicular and Positive x-axis is:

$$\implies \theta = \tan^{-1}(\infty) \quad (2.0.29)$$

$$\implies \theta = 90^\circ \quad (2.0.30)$$

5) For line, $(1 \ -1)\mathbf{x} = 4$

- We have:

$$c = 4, \mathbf{n} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \quad (2.0.31)$$

- Using (2.0.4) we get:

$$d = \frac{|c|}{\|\mathbf{n}\|} \quad (2.0.32)$$

$$d = \frac{4}{\sqrt{1+1}} \quad (2.0.33)$$

$$d = \frac{4}{\sqrt{2}} \quad (2.0.34)$$

$$d = \frac{4}{1.41} \quad (2.0.35)$$

$$d = 2.828 \text{ units} \quad (2.0.36)$$

- Using (2.0.11) the slope of the line perpen-

dicular to given line is:

$$m_2 = \frac{b}{a} \quad (2.0.37)$$

$$m_2 = \frac{1}{-1} = -1 \quad (2.0.38)$$

- Also, Using (2.0.13) the angle between perpendicular and positive x-axis is:

$$\theta = \tan^{-1}(m_2) \quad (2.0.39)$$

$$\theta = \tan^{-1}(-1) (\because m_2 = -1) \quad (2.0.40)$$

$$\theta = -45^\circ \quad (2.0.41)$$

6) If,

\mathbf{d} = Perpendicular distance of line from origin

\mathbf{m}_2 = Slope of the perpendicular to the line

θ = Angle of perpendicular with positive x-axis.

All the given and calculated data can be tabularised in table as 2.1:

| | Line1 | Line2 | Line3 |
|----------------------------|--|--|---|
| c | 8 | 2 | 4 |
| n | $\begin{pmatrix} 1 \\ -\sqrt{3} \end{pmatrix}$ | $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ | $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$ |
| d(units) | 4 | 2 | 2.828 |
| m₂ | $-\sqrt{3}$ | ∞ | 1 |
| θ | -60° | 90° | -45° |

TABLE 2.1: Data:-Given and Calculated