# Matrix Theory (EE5609) Assignment-1

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***Abstract*—This document contains the solution to find the direction vector for a straight line drawn through the given point**

Download all python codes from

https://github.com/EE20RESCH11008/Matrix-Theory/tree/master/Assignment-1/Code

and latex-tikz codes from

https://github.com/EE20RESCH11008/Matrix-Theory/tree/master/Assignment-1

## 1 Problem

Find the direction in which a straight line must be drawn through the point $\mathbf{B}$ so that its point of intersection with the line may be the distance of 3 units from this point, where

$$\mathbf{B} = \begin{pmatrix} -1 \\ 2 \end{pmatrix} \tag{1.0.1}$$

and the line

$$\begin{pmatrix} 1 & 1 \end{pmatrix}\mathbf{x} = 4 \tag{1.0.2}$$

## 2 Solution

The given equation of the line in parametric form:

$$\mathbf{x} = \mathbf{A} + \lambda\mathbf{m} \tag{2.0.1}$$

where,

$$\mathbf{A} = \begin{pmatrix} 3 \\ 1 \end{pmatrix} \tag{2.0.2}$$

$$\mathbf{m} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \tag{2.0.3}$$

If $\mathbf{x}$ be the point of intersection,

$$\|\mathbf{x} - \mathbf{B}\| = 3 \tag{2.0.4}$$

$$\|\mathbf{A} + \lambda\mathbf{m} - \mathbf{B}\| = 3 \tag{2.0.5}$$

$$(\mathbf{A} + \lambda\mathbf{m} - \mathbf{B})^T(\mathbf{A} + \lambda\mathbf{m} - \mathbf{B}) = 9 \tag{2.0.6}$$

$$|\mathbf{m}|^2\lambda^2 + [(\mathbf{A} - \mathbf{B})^T\mathbf{m} + \mathbf{m}^T(\mathbf{A} - \mathbf{B})]\lambda + |\mathbf{A} - \mathbf{B}|^2 - 9 = 0 \tag{2.0.7}$$

$$[(\mathbf{A} - \mathbf{B})^T\mathbf{m} = \mathbf{m}^T(\mathbf{A} - \mathbf{B})] \tag{2.0.8}$$

$$|\mathbf{m}|^2\lambda^2 + [2(\mathbf{A} - \mathbf{B})^T\mathbf{m})]\lambda + |\mathbf{A} - \mathbf{B}|^2 - 9 = 0 \tag{2.0.9}$$

$$2\lambda^2 + 10\lambda + 8 = 0 \tag{2.0.10}$$

$$\lambda = -4 \quad or \quad \lambda = -1 \tag{2.0.11}$$

The point of intersection,

$$\boxed{\therefore \mathbf{x} = \begin{pmatrix} -1 \\ 5 \end{pmatrix} or \begin{pmatrix} 2 \\ 2 \end{pmatrix}} \tag{2.0.12}$$

The direction vector,

$$\mathbf{v} = \mathbf{B} - \mathbf{x} \tag{2.0.13}$$

$$\boxed{\mathbf{v} = \begin{pmatrix} 0 \\ -3 \end{pmatrix} or \begin{pmatrix} -3 \\ 0 \end{pmatrix}} \tag{2.0.14}$$