

# Matrix Theory (EE5609) Assignment 1

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**Abstract**—This assignment solves a problem on checking whether two lines are parallel or perpendicular.

Below is the link to python code solution of this problem

## 1 PROBLEM STATEMENT

Show that the line through the points  $\begin{pmatrix} 1 \\ -1 \\ 2 \end{pmatrix}$  and  $\begin{pmatrix} 3 \\ 4 \\ -2 \end{pmatrix}$  is parallel to the line through the points  $\begin{pmatrix} 0 \\ 3 \\ 2 \end{pmatrix}$  and  $\begin{pmatrix} 3 \\ 5 \\ 6 \end{pmatrix}$ .

## 2 THEORY

The direction vector  $\mathbf{A}$  for a line through the points  $\begin{pmatrix} x_1 \\ y_1 \\ z_1 \end{pmatrix}$  and  $\begin{pmatrix} x_2 \\ y_2 \\ z_2 \end{pmatrix}$  is given by  $\mathbf{A} = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$  where

$$a_1 = x_2 - x_1 \quad (2.0.1)$$

$$b_1 = y_2 - y_1 \quad (2.0.2)$$

$$c_1 = z_2 - z_1 \quad (2.0.3)$$

and  $\hat{i}$ ,  $\hat{j}$ ,  $\hat{k}$  are unit vectors along x-axis, y-axis and z-axis respectively.

For two lines having direction vectors  $\mathbf{A}$  and  $\mathbf{B}$  respectively, they will be perpendicular if

$$\mathbf{A} \cdot \mathbf{B} = 0 \quad (2.0.4)$$

And the two lines will be parallel if

$$\mathbf{A} \times \mathbf{B} = \mathbf{0} \quad (2.0.5)$$

## 3 SOLUTION

From the theory, the direction vector for the line through the points  $\begin{pmatrix} 1 \\ -1 \\ 2 \end{pmatrix}$  and  $\begin{pmatrix} 3 \\ 4 \\ -2 \end{pmatrix}$  is  $\mathbf{A} = 2\hat{i} + 5\hat{j} - 4\hat{k}$

(using equations 2.0.1, 2.0.2, 2.0.3). Similarly, the direction ratios for the line through the points  $\begin{pmatrix} 0 \\ 3 \\ 2 \end{pmatrix}$

and  $\begin{pmatrix} 3 \\ 5 \\ 6 \end{pmatrix}$  is  $\mathbf{B} = 3\hat{i} + 2\hat{j} + 4\hat{k}$  (using equations 2.0.1, 2.0.2, 2.0.3).

To check if the two lines are perpendicular, we perform scalar product of the two direction vectors  $\mathbf{A}$  and  $\mathbf{B}$  as follows

$$\begin{aligned} \mathbf{A} \cdot \mathbf{B} &= (2\hat{i} + 5\hat{j} - 4\hat{k}) \cdot (3\hat{i} + 2\hat{j} + 4\hat{k}) \\ \Rightarrow \mathbf{A} \cdot \mathbf{B} &= (2 \cdot 3)(\hat{i} \cdot \hat{i}) + (5 \cdot 2)(\hat{j} \cdot \hat{j}) + (-4 \cdot 4)(\hat{k} \cdot \hat{k}) \\ &\Rightarrow \mathbf{A} \cdot \mathbf{B} = 6 + 10 - 16 \\ &\Rightarrow \mathbf{A} \cdot \mathbf{B} = 0 \end{aligned}$$

Thus the direction vectors of the two lines satisfies the equation 2.0.4, hence proved that the lines are **perpendicular**. Hence they are not **parallel** with each other.

**Python Code:** The python code for the above solution can be found at - [https://github.com/Arko98/EE5609/blob/master/Assignment\\_1/Codes/Solution\\_1.py](https://github.com/Arko98/EE5609/blob/master/Assignment_1/Codes/Solution_1.py)