ASSIGNMENT-3

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1 QUESTION No-2.36 (A) (LINEAR FORMS)

Find the equation of the planes that passes through three points $\begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix}, \begin{pmatrix} 6 \\ 4 \\ -5 \end{pmatrix}, \begin{pmatrix} -4 \\ -2 \\ 3 \end{pmatrix}$

2 SOLUTION

$$\mathbf{R} = \begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix}, \mathbf{S} = \begin{pmatrix} 6 \\ 4 \\ -5 \end{pmatrix} \text{and} \mathbf{T} = \begin{pmatrix} -4 \\ -2 \\ 3 \end{pmatrix} \quad (2.0.1)$$

If the equation of the plane is given by

$$\mathbf{n}^T \mathbf{x} = 1 \quad (2.0.2)$$

$$\begin{pmatrix} 1 & 1 & -1 \\ 6 & 4 & -5 \\ -4 & -2 & 3 \end{pmatrix} \mathbf{n} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} \quad (2.0.3)$$

Row reducing the augmented matrix,

$$\begin{pmatrix} 1 & 1 & -1 & 1 \\ 6 & 4 & -5 & 1 \\ -4 & -2 & 3 & 1 \end{pmatrix} \xleftarrow{R_2 \to R_2 - 6R_1} \begin{pmatrix} 1 & 1 & -1 & 1 \\ 0 & -2 & 1 & -5 \\ -4 & -2 & 3 & 1 \end{pmatrix}$$
$$(2.0.4)$$

$$\xleftarrow{R_3 \to R_3 + 4R_1} \begin{pmatrix} 1 & 1 & -1 & 1 \\ 0 & -2 & 1 & -5 \\ 0 & 2 & -1 & 5 \end{pmatrix}$$
$$(2.0.5)$$

$$\xleftarrow{R_2 \to \frac{-R_2}{3}} \begin{pmatrix} 1 & 1 & -1 & 1 \\ 0 & 1 & \frac{-1}{2} & \frac{5}{2} \\ 0 & 2 & -1 & 5 \end{pmatrix}$$
$$(2.0.6)$$

$$\xleftarrow{R_1 \to R_1 - R_2} \begin{pmatrix} 1 & 0 & \frac{-1}{2} & \frac{-3}{2} \\ 0 & 1 & \frac{-1}{2} & \frac{5}{2} \\ 0 & 2 & -1 & 5 \end{pmatrix}$$
$$(2.0.7)$$

$$\xleftarrow{R_3 \to R_3 - 2R_2} \begin{pmatrix} 1 & 0 & \frac{-1}{2} & \frac{-3}{2} \\ 0 & 1 & \frac{-1}{2} & \frac{5}{2} \\ 0 & 0 & 0 & 0 \end{pmatrix}$$
$$(2.0.8)$$

$$\begin{pmatrix} 1 & 0 & -0.5 & -1.5 \\ 0 & 1 & -0.5 & 2.5 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$
$$(2.0.9)$$

Number of Non zero row =2. Rank of Matrix =2 For the linear equation to have infinite solution. Rank(coefficient matrix) = Rank(Augmented matrix)and both not equal to Rank (Full matrix)

$$\begin{pmatrix} 1 & 1 & -1 \\ 6 & 4 & -5 \\ -4 & -2 & 3 \end{pmatrix} \quad (2.0.10)$$

$$\xleftarrow{R_2 \to R_2 - 6R_1} \begin{pmatrix} 1 & 1 & -1 \\ 0 & -2 & 1 \\ -4 & -2 & -3 \end{pmatrix} \quad\quad (2.0.11)$$

$$\xleftarrow{R_3 \to R_3 + 4R_1} \begin{pmatrix} 1 & 1 & -1 \\ 0 & -2 & 1 \\ 0 & 2 & -1 \end{pmatrix} \quad\quad (2.0.12)$$

$$\xleftarrow{R_2 \to \frac{-R_2}{2}} \begin{pmatrix} 1 & 1 & -1 \\ 0 & 1 & \frac{-1}{2} \\ 0 & 2 & -1 \end{pmatrix} \quad\quad (2.0.13)$$

$$\xleftarrow{R_1 \to R_1 - R_2} \begin{pmatrix} 1 & 0 & \frac{-1}{2} \\ 0 & 1 & \frac{-1}{2} \\ 0 & 2 & -1 \end{pmatrix} \quad\quad (2.0.14)$$

$$\xleftarrow{R_3 \to R_3 - 2R_2} \begin{pmatrix} 1 & 0 & \frac{-1}{2} \\ 0 & 1 & \frac{-1}{2} \\ 0 & 0 & 0 \end{pmatrix} \quad\quad (2.0.15)$$

$$\begin{pmatrix} 1 & 0 & -0.5 \\ 0 & 1 & -0.5 \\ 0 & 0 & 0 \end{pmatrix} \quad\quad (2.0.16)$$
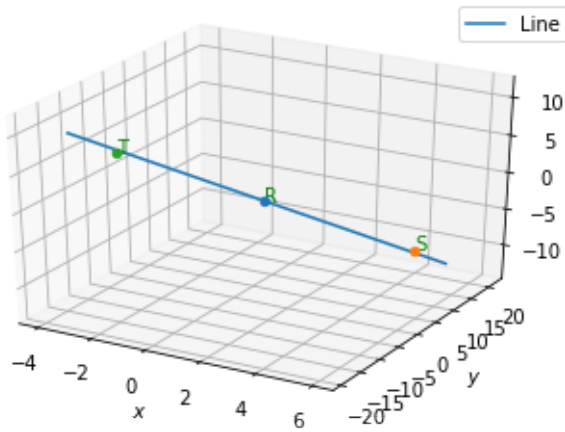
Rank of matrix =3
Rank of coefficient matrix = 0

Fig. 2.1: plot of the line