2.2.14

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Question:
The angle between the line

$$\mathbf{r} = \left(5\hat{i} - \hat{j} - 4\hat{k}\right) + \lambda\left(2\hat{i} - \hat{j} + \hat{k}\right) \tag{1}$$

and the plane

$$\mathbf{r}.\left(3\hat{i} - 4\hat{j} - \hat{k}\right) + 5 = 0 \tag{2}$$

is
Solution: The given line can be expressed in the form as

$$\mathbf{r} = \begin{pmatrix} 5 \\ -1 \\ -4 \end{pmatrix} + \lambda \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} \tag{3}$$

Hence the vector direction of this line is

$$\begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} \tag{4}$$

the normal vector of the given plane is

$$\begin{pmatrix} 3 \\ -4 \\ -1 \end{pmatrix} \tag{5}$$

by the formula

$$\cos\theta = \frac{\mathbf{a}^T\mathbf{b}}{\|\mathbf{a}\|\|\mathbf{b}\|} \tag{6}$$

Thus the cosine of the angle between the two is

$$\frac{3\sqrt{3}}{2\sqrt{13}} \tag{7}$$

which is sine of the angle between the plane and the line.
$\therefore$ The angle between the line and plane is $\sin^{-1}\frac{3\sqrt{3}}{2\sqrt{13}}$

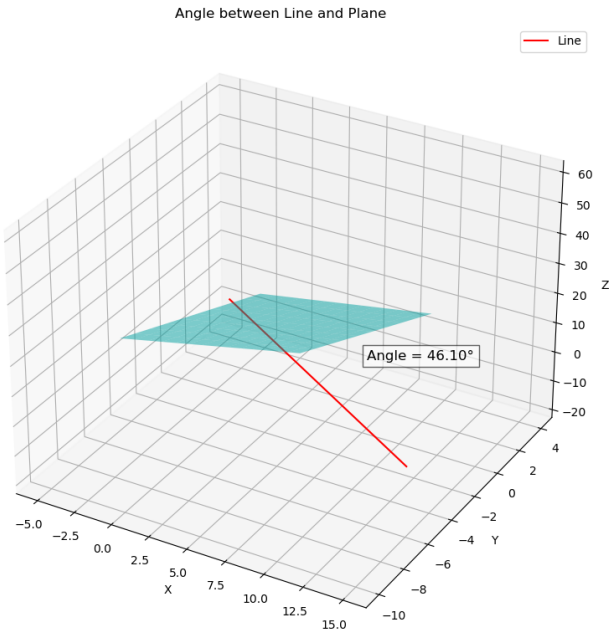

Fig. 0. Caption