5.4.35

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Question)

Find inverse with elementary transformations of matrix

$$\begin{pmatrix} 0 & 1 & 2 \\ -1 & 0 & -3 \\ -2 & 3 & 0 \end{pmatrix} \tag{1}$$

Solution

For elementary transformation, matrix can be written in form

$$\left[\begin{array}{ccc|ccc} 0 & 1 & 2 & 1 & 0 & 0 \\ -1 & 0 & -3 & 0 & 1 & 0 \\ -2 & 3 & 0 & 0 & 0 & 1 \end{array}\right] \tag{2}$$

Here, it is in form

$$[\mathbf{A}|\mathbf{I}] \tag{3}$$

Solution

With elementary transformation, we can get

$$\left[\mathbf{I}|\mathbf{A}^{-1}\right] \tag{4}$$

So now in (2)

$$\left[\begin{array}{ccc|ccc} 0 & 1 & 2 & 1 & 0 & 0 \\ -1 & 0 & -3 & 0 & 1 & 0 \\ -2 & 3 & 0 & 0 & 0 & 1 \end{array}\right] \tag{5}$$

Solution

$$\xrightarrow{R_1 \to R_1 - R_2} \left[\begin{array}{ccc|ccc} 1 & 1 & 5 & 1 & -1 & 0 \\ -1 & 0 & -3 & 0 & 1 & 0 \\ -2 & 3 & 0 & 0 & 0 & 1 \end{array}\right] \tag{6}$$

$$\xrightarrow{R_2 \to R_1 + R_2} \left[\begin{array}{ccc|ccc} 1 & 1 & 5 & 1 & -1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ -2 & 3 & 0 & 0 & 0 & 1 \end{array}\right] \tag{7}$$

Solution

$$\xrightarrow{R_1 \to R_1 - R_2} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & -1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ -2 & 3 & 0 & 0 & 0 & 1 \end{array}\right] \tag{8}$$

$$\xrightarrow{R_3 \to R_3 + 2R_1} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & -1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ 0 & 3 & 6 & 0 & -2 & 1 \end{array}\right] \tag{9}$$

Solution

$$\xrightarrow{R_3 \to R_3 - 3R_2} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & -1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ 0 & 0 & 0 & -3 & -2 & 1 \end{array}\right] \tag{10}$$

At this point, we have obtained a row of all zeros on the left side of the augmented matrix. It's now impossible to continue the process to form the identity matrix.

Because the RREF of the original matrix is not the identity matrix, the matrix is singular and its inverse does not exist.

Direct Python

```
import numpy as np

a= np.array([[0,1,2],[-1,0,-3],[-2,3,0]])
det= np.linalg.det(a)

if det==0:
    print("No inverse exist")
else:
    inv = np.linalg.inv(a)
    print(inv)
```