5.4.20

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Using elementary transformations, find the inverse of the following matrix.

$$\begin{pmatrix} 3 & -1 \\ -4 & 2 \end{pmatrix} \tag{1}$$

Given:

$$A = \begin{pmatrix} 3 & -1 \\ -4 & 2 \end{pmatrix} \tag{2}$$

Let A^{-1} be the inverse of the given matrix A:

$$AA^{-1} = I \tag{3}$$

Augmented Matrix

The augmented matrix $A|I$:

$$\begin{pmatrix} 3 & -1 & \bigm| & 1 & 0 \\ -4 & 2 & \bigm| & 0 & 1 \end{pmatrix} R_1 \to \frac{R_1}{3} \tag{4}$$

$$\begin{pmatrix} 1 & \frac{-1}{3} & \bigm| & \frac{1}{3} & 0 \\ -4 & 2 & \bigm| & 0 & 1 \end{pmatrix} R_{22} + 4R_1 \tag{5}$$

$$\begin{pmatrix} 1 & \frac{-1}{3} & \bigm| & \frac{1}{3} & 0 \\ 0 & \frac{2}{3} & \bigm| & \frac{4}{3} & 1 \end{pmatrix} R_2 \to \frac{3}{2} R_2 \tag{6}$$

$$\begin{pmatrix} 1 & \frac{-1}{3} & \bigm| & \frac{1}{3} & 0 \\ 0 & 1 & \bigm| & 2 & \frac{3}{2} \end{pmatrix} R_1 \to R_1 + \frac{1}{3} R_2 \tag{7}$$

$$\begin{pmatrix} 1 & 0 & \bigm| & 1 & \frac{1}{2} \\ 0 & 1 & \bigm| & 2 & \frac{3}{2} \end{pmatrix} \tag{8}$$

Therefore,

$$A^{-1} = \begin{pmatrix} 1 & \frac{1}{2} \\ 2 & \frac{3}{2} \end{pmatrix} \tag{9}$$

C Code

```c
#include<stdio.h>

void define_matrix(double *out_data){
    out_data[0] = 3.0;
    out_data[1] = -1.0;
    out_data[2] = -4.0;
    out_data[3] = 2.0;
}
```

Python Code 1

```python
import ctypes as ct
import numpy as np
lib = ct.CDLL("./problem.so")
entry = ct.c_double*4
lib.define_matrix.argtypes = [ct.POINTER(ct.c_double)]
data = entry()
lib.define_matrix(data)
A = np.array([[data[0],data[1]],
              [data[2],data[3]]])
Ainv = np.linalg.inv(A)
print("Inverse of given matrix is\n", Ainv)
```