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def matrix\_maker():  
 # A basic code for matrix input from user  
  
 R = int(input("Enter the number of rows:"))  
 C = int(input("Enter the number of columns:"))  
  
 # Initialize matrix  
 matrix = []  
 print("Enter the entries rowwise:")  
  
 # For user input  
 for i in range(R): # A for loop for row entries  
 a = []  
 for j in range(C): # A for loop for column entries  
 a.append(int(input()))  
 matrix.append(a)  
  
 # For printing the matrix  
 for i in range(R):  
 for j in range(C):  
 print(matrix[i][j], end=" ")  
 print()  
 return matrix

def solver():  
 matrix = []  
 """A:coefficient"""  
 print("enter A:")  
 print("")  
 a = matrix\_maker()  
 print("")  
  
 """"B:constant"""  
 print("enter B:")  
 print("")  
 b = matrix\_maker()  
  
 augmented = np.hstack([a, b])  
 print("augmented matrix:")  
 print(augmented)

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def add\_row(A, k, i, j):  
 *"Add k times row j to row i in matrix A."* n = A.shape[0]  
 E = np.eye(n)  
 if i == j:  
 E[i, i] = k + 1  
 else:  
 E[i, j] = k  
 return E @ A  
  
  
def scale\_row(A, k, i):  
 *"Multiply row i by k in matrix A."* n = A.shape[0]  
 E = np.eye(n)  
 E[i, i] = k  
 return E @ A  
  
  
def switch\_rows(A, i, j):  
 *"Switch rows i and j in matrix A."* n = A.shape[0]  
 E = np.eye(n)  
 E[i, i] = 0  
 E[j, j] = 0  
 E[i, j] = 1  
 E[j, i] = 1  
 return E @ A

enter A:

Enter the number of rows:3

Enter the number of columns:3

Enter the entries rowwise:

6

15

1

8

7

12

2

7

8

6 15 1

8 7 12

2 7 8

enter B:

Enter the number of rows:3

Enter the number of columns:1

Enter the entries rowwise:

2

14

10

2

14

10

augmented matrix:

[[ 6 15 1 2]

[ 8 7 12 14]

[ 2 7 8 10]]

M1:

[[ 1. 2.5 0.16666667 0.33333333]

[ 8. 7. 12. 14. ]

[ 2. 7. 8. 10. ]]

M2:

[[ 1. 2.5 0.16666667 0.33333333]

[ 0. -13. 10.66666667 11.33333333]

[ 2. 7. 8. 10. ]]

M3:

[[ 1. 2.5 0.16666667 0.33333333]

[ 0. -13. 10.66666667 11.33333333]

[ 0. 2. 7.66666667 9.33333333]]

M4:

[[ 1. 2.5 0.16666667 0.33333333]

[ 0. 1. -0.82051282 -0.87179487]

[ 0. 2. 7.66666667 9.33333333]]

M5:

[[ 1. 2.5 0.16666667 0.33333333]

[ 0. 1. -0.82051282 -0.87179487]

[ 0. 0. 9.30769231 11.07692308]]

M6:

[[ 1. 2.5 0.16666667 0.33333333]

[ 0. 1. -0.82051282 -0.87179487]

[ 0. 0. 1. 1.19008264]]

M7:

[[1. 2.5 0.16666667 0.33333333]

[0. 1. 0. 0.1046832 ]

[0. 0. 1. 1.19008264]]

M8:

[[1. 2.5 0. 0.13498623]

[0. 1. 0. 0.1046832 ]

[0. 0. 1. 1.19008264]]

M9:

[[ 1. 0. 0. -0.12672176]

[ 0. 1. 0. 0.1046832 ]

[ 0. 0. 1. 1.19008264]]

X: [[-0.12672176]

[ 0.1046832 ]

[ 1.19008264]]

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def invertible():  
 # return a.shape[0] == a.shape[1] and np.linalg.matrix\_rank(a) == a.shape[0]  
 try:  
 print(linalg.inv(matrix\_maker()))  
 except:  
 print("not consistent")

معکوس ماتریس ضرائب در مثال:

[[ 0.22603122 0.02982163 0.34225195 0.19732441 0.2416388 ]

[ 0.18729097 -0.07023411 -0.48829431 -0.05351171 -0.16722408]

[ 0.10953177 0.05267559 -0.13377926 0.04013378 -0.12458194]

[ 0.03790412 0.06911929 -0.12263099 0.0367893 -0.01003344]

[ 0.04821628 0.11733556 0.29988852 0.01003344 0.15635452]]

augmented matrix:

[[ 1 3 2 -4 3 -3]

[ -2 -1 2 6 4 19]

[ 0 -1 3 -5 1 -2]

[ 3 -4 2 5 -7 -11]

[ 1 2 -8 6 1 4]]

Solution of linear equations:

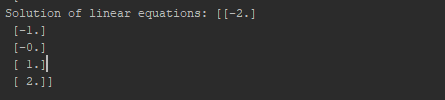
[[-2.]

[-1.]

[-0.]

[ 1.]

[ 2.]]



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| **Row Operation 1:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | -2 | -1 | 2 | 6 | 4 | 19 | | 0 | -1 | 3 | -5 | 1 | -2 | | 3 | -4 | 2 | 5 | -7 | -11 | | 1 | 2 | -8 | 6 | 1 | 4 | | | add **2** times the 1st row to the 2nd row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 5 | 6 | -2 | 10 | 13 | | 0 | -1 | 3 | -5 | 1 | -2 | | 3 | -4 | 2 | 5 | -7 | -11 | | 1 | 2 | -8 | 6 | 1 | 4 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 2:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 5 | 6 | -2 | 10 | 13 | | 0 | -1 | 3 | -5 | 1 | -2 | | 3 | -4 | 2 | 5 | -7 | -11 | | 1 | 2 | -8 | 6 | 1 | 4 | | | add **-3** times the 1st row to the 4th row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 5 | 6 | -2 | 10 | 13 | | 0 | -1 | 3 | -5 | 1 | -2 | | 0 | -13 | -4 | 17 | -16 | -2 | | 1 | 2 | -8 | 6 | 1 | 4 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 3:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 5 | 6 | -2 | 10 | 13 | | 0 | -1 | 3 | -5 | 1 | -2 | | 0 | -13 | -4 | 17 | -16 | -2 | | 1 | 2 | -8 | 6 | 1 | 4 | | | add **-1** times the 1st row to the 5th row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 5 | 6 | -2 | 10 | 13 | | 0 | -1 | 3 | -5 | 1 | -2 | | 0 | -13 | -4 | 17 | -16 | -2 | | 0 | -1 | -10 | 10 | -2 | 7 | | |

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| **Row Operation 4:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 5 | 6 | -2 | 10 | 13 | | 0 | -1 | 3 | -5 | 1 | -2 | | 0 | -13 | -4 | 17 | -16 | -2 | | 0 | -1 | -10 | 10 | -2 | 7 | | | multiply the 2nd row by **1/5** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | -1 | 3 | -5 | 1 | -2 | | 0 | -13 | -4 | 17 | -16 | -2 | | 0 | -1 | -10 | 10 | -2 | 7 | | |

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| **Row Operation 5:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | -1 | 3 | -5 | 1 | -2 | | 0 | -13 | -4 | 17 | -16 | -2 | | 0 | -1 | -10 | 10 | -2 | 7 | | | add **1** times the 2nd row to the 3rd row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 21   5 | -27   5 | 3 | 3   5 | | 0 | -13 | -4 | 17 | -16 | -2 | | 0 | -1 | -10 | 10 | -2 | 7 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 6:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 21   5 | -27   5 | 3 | 3   5 | | 0 | -13 | -4 | 17 | -16 | -2 | | 0 | -1 | -10 | 10 | -2 | 7 | | | add **13** times the 2nd row to the 4th row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 21   5 | -27   5 | 3 | 3   5 | | 0 | 0 | 58   5 | 59   5 | 10 | 159   5 | | 0 | -1 | -10 | 10 | -2 | 7 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 7:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 21   5 | -27   5 | 3 | 3   5 | | 0 | 0 | 58   5 | 59   5 | 10 | 159   5 | | 0 | -1 | -10 | 10 | -2 | 7 | | | add **1** times the 2nd row to the 5th row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 21   5 | -27   5 | 3 | 3   5 | | 0 | 0 | 58   5 | 59   5 | 10 | 159   5 | | 0 | 0 | -44   5 | 48   5 | 0 | 48   5 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 8:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 21   5 | -27   5 | 3 | 3   5 | | 0 | 0 | 58   5 | 59   5 | 10 | 159   5 | | 0 | 0 | -44   5 | 48   5 | 0 | 48   5 | | | multiply the 3rd row by **5/21** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 58   5 | 59   5 | 10 | 159   5 | | 0 | 0 | -44   5 | 48   5 | 0 | 48   5 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 9:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 58   5 | 59   5 | 10 | 159   5 | | 0 | 0 | -44   5 | 48   5 | 0 | 48   5 | | | add **-58/5** times the 3rd row to the 4th row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 187   7 | 12   7 | 211   7 | | 0 | 0 | -44   5 | 48   5 | 0 | 48   5 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 10:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 187   7 | 12   7 | 211   7 | | 0 | 0 | -44   5 | 48   5 | 0 | 48   5 | | | add **44/5** times the 3rd row to the 5th row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 187   7 | 12   7 | 211   7 | | 0 | 0 | 0 | -12   7 | 44   7 | 76   7 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 11:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 187   7 | 12   7 | 211   7 | | 0 | 0 | 0 | -12   7 | 44   7 | 76   7 | | | multiply the 4th row by **7/187** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 1 | 12   187 | 211   187 | | 0 | 0 | 0 | -12   7 | 44   7 | 76   7 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 12:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 1 | 12   187 | 211   187 | | 0 | 0 | 0 | -12   7 | 44   7 | 76   7 | | | add **12/7** times the 4th row to the 5th row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 1 | 12   187 | 211   187 | | 0 | 0 | 0 | 0 | 1196   187 | 2392   187 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 13:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 1 | 12   187 | 211   187 | | 0 | 0 | 0 | 0 | 1196   187 | 2392   187 | | | multiply the 5th row by **187/1196** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 1 | 12   187 | 211   187 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 14:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 1 | 12   187 | 211   187 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **-12/187** times the 5th row to the 4th row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 15:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 5   7 | 1   7 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **-5/7** times the 5th row to the 3rd row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 0 | -9   7 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 16:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 2 | 13   5 | | 0 | 0 | 1 | -9   7 | 0 | -9   7 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **-2** times the 5th row to the 2nd row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 0 | -7   5 | | 0 | 0 | 1 | -9   7 | 0 | -9   7 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Row Operation 17:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 3 | -3 | | 0 | 1 | 6   5 | -2   5 | 0 | -7   5 | | 0 | 0 | 1 | -9   7 | 0 | -9   7 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **-3** times the 5th row to the 1st row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 0 | -9 | | 0 | 1 | 6   5 | -2   5 | 0 | -7   5 | | 0 | 0 | 1 | -9   7 | 0 | -9   7 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Row Operation 18:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 0 | -9 | | 0 | 1 | 6   5 | -2   5 | 0 | -7   5 | | 0 | 0 | 1 | -9   7 | 0 | -9   7 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **9/7** times the 4th row to the 3rd row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 0 | -9 | | 0 | 1 | 6   5 | -2   5 | 0 | -7   5 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Row Operation 19:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 0 | -9 | | 0 | 1 | 6   5 | -2   5 | 0 | -7   5 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **2/5** times the 4th row to the 2nd row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 0 | -9 | | 0 | 1 | 6   5 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Row Operation 20:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | -4 | 0 | -9 | | 0 | 1 | 6   5 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **4** times the 4th row to the 1st row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | 0 | 0 | -5 | | 0 | 1 | 6   5 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Row Operation 21:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | 0 | 0 | -5 | | 0 | 1 | 6   5 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **-6/5** times the 3rd row to the 2nd row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | 0 | 0 | -5 | | 0 | 1 | 0 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Row Operation 22:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 2 | 0 | 0 | -5 | | 0 | 1 | 0 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **-2** times the 3rd row to the 1st row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 0 | 0 | 0 | -5 | | 0 | 1 | 0 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Row Operation 23:** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 3 | 0 | 0 | 0 | -5 | | 0 | 1 | 0 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | | add **-3** times the 2nd row to the 1st row | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | 0 | 0 | 0 | 0 | -2 | | 0 | 1 | 0 | 0 | 0 | -1 | | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | | 0 | 0 | 0 | 0 | 1 | 2 | | |

augmented matrix:

[[ 1 3 2 -4 3 -3]

[ -2 -1 2 6 4 19]

[ 0 -1 3 -5 1 -2]

[ 3 -4 2 5 -7 -11]

[ 1 2 -8 6 1 4]]

M1: [[ 1. 3. 2. -4. 3. -3.]

[ 0. 5. 6. -2. 10. 13.]

[ 0. -1. 3. -5. 1. -2.]

[ 3. -4. 2. 5. -7. -11.]

[ 1. 2. -8. 6. 1. 4.]]

M2: [[ 1. 3. 2. -4. 3. -3.]

[ 0. 5. 6. -2. 10. 13.]

[ 0. -1. 3. -5. 1. -2.]

[ 0. -13. -4. 17. -16. -2.]

[ 1. 2. -8. 6. 1. 4.]]

Temp: [[ 1. 3. 2. -4. 3. -3.]

[ 0. 5. 6. -2. 10. 13.]

[ 0. -1. 3. -5. 1. -2.]

[ 0. -13. -4. 17. -16. -2.]

[ 0. -1. -10. 10. -2. 7.]]

M3: [[ 1. 3. 2. -4. 3. -3. ]

[ 0. 1. 1.2 -0.4 2. 2.6]

[ 0. -1. 3. -5. 1. -2. ]

[ 0. -13. -4. 17. -16. -2. ]

[ 0. -1. -10. 10. -2. 7. ]]

M4: [[ 1. 3. 2. -4. 3. -3. ]

[ 0. 1. 1.2 -0.4 2. 2.6]

[ 0. 0. 4.2 -5.4 3. 0.6]

[ 0. -13. -4. 17. -16. -2. ]

[ 0. -1. -10. 10. -2. 7. ]]

M5: [[ 1. 3. 2. -4. 3. -3. ]

[ 0. 1. 1.2 -0.4 2. 2.6]

[ 0. 0. 4.2 -5.4 3. 0.6]

[ 0. 0. 11.6 11.8 10. 31.8]

[ 0. -1. -10. 10. -2. 7. ]]

M6: [[ 1. 3. 2. -4. 3. -3. ]

[ 0. 1. 1.2 -0.4 2. 2.6]

[ 0. 0. 4.2 -5.4 3. 0.6]

[ 0. 0. 11.6 11.8 10. 31.8]

[ 0. 0. -8.8 9.6 0. 9.6]]

M7: [[ 1. 3. 2. -4. 3. -3. ]

[ 0. 1. 1.2 -0.4 2. 2.6 ]

[ 0. 0. 1. -1.28571429 0.71428571 0.14285714]

[ 0. 0. 11.6 11.8 10. 31.8 ]

[ 0. 0. -8.8 9.6 0. 9.6 ]]

M8: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

3.00000000e+00 -3.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

2.00000000e+00 2.60000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

7.14285714e-01 1.42857143e-01]

[ 0.00000000e+00 0.00000000e+00 1.77635684e-15 2.67142857e+01

1.71428571e+00 3.01428571e+01]

[ 0.00000000e+00 0.00000000e+00 -8.80000000e+00 9.60000000e+00

0.00000000e+00 9.60000000e+00]]

M9: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

3.00000000e+00 -3.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

2.00000000e+00 2.60000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

7.14285714e-01 1.42857143e-01]

[ 0.00000000e+00 0.00000000e+00 1.77635684e-15 2.67142857e+01

1.71428571e+00 3.01428571e+01]

[ 0.00000000e+00 0.00000000e+00 0.00000000e+00 -1.71428571e+00

6.28571429e+00 1.08571429e+01]]

M10: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

3.00000000e+00 -3.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

2.00000000e+00 2.60000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

7.14285714e-01 1.42857143e-01]

[ 0.00000000e+00 0.00000000e+00 6.64946410e-17 1.00000000e+00

6.41711230e-02 1.12834225e+00]

[ 0.00000000e+00 0.00000000e+00 0.00000000e+00 -1.71428571e+00

6.28571429e+00 1.08571429e+01]]

M11: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

3.00000000e+00 -3.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

2.00000000e+00 2.60000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

7.14285714e-01 1.42857143e-01]

[ 0.00000000e+00 0.00000000e+00 6.64946410e-17 1.00000000e+00

6.41711230e-02 1.12834225e+00]

[ 0.00000000e+00 0.00000000e+00 1.13990813e-16 -2.88657986e-15

6.39572193e+00 1.27914439e+01]]

M12: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

3.00000000e+00 -3.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

2.00000000e+00 2.60000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

7.14285714e-01 1.42857143e-01]

[ 0.00000000e+00 0.00000000e+00 6.64946410e-17 1.00000000e+00

6.41711230e-02 1.12834225e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M13: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

3.00000000e+00 -3.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

2.00000000e+00 2.60000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

7.14285714e-01 1.42857143e-01]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M14: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

3.00000000e+00 -3.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

2.00000000e+00 2.60000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

-1.11022302e-16 -1.28571429e+00]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M15: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

3.00000000e+00 -3.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

0.00000000e+00 -1.40000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

-1.11022302e-16 -1.28571429e+00]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M16: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

0.00000000e+00 -9.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

0.00000000e+00 -1.40000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 -1.28571429e+00

-1.11022302e-16 -1.28571429e+00]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M17: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

0.00000000e+00 -9.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 -4.00000000e-01

0.00000000e+00 -1.40000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 2.22044605e-16

-7.53365624e-17 -2.22044605e-16]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M18: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 -4.00000000e+00

0.00000000e+00 -9.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 8.88178420e-16

1.11022302e-17 -1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 2.22044605e-16

-7.53365624e-17 -2.22044605e-16]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M19: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 1.33226763e-15

1.11022302e-16 -5.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 1.20000000e+00 8.88178420e-16

1.11022302e-17 -1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 2.22044605e-16

-7.53365624e-17 -2.22044605e-16]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M20: [[ 1.00000000e+00 3.00000000e+00 2.00000000e+00 1.33226763e-15

1.11022302e-16 -5.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 2.22044605e-16 6.21724894e-16

1.01506105e-16 -1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 2.22044605e-16

-7.53365624e-17 -2.22044605e-16]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M21: [[ 1.00000000e+00 3.00000000e+00 4.44089210e-16 8.88178420e-16

2.61695427e-16 -5.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 2.22044605e-16 6.21724894e-16

1.01506105e-16 -1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 2.22044605e-16

-7.53365624e-17 -2.22044605e-16]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

M22: [[ 1.00000000e+00 0.00000000e+00 -2.22044605e-16 -9.76996262e-16

-4.28228881e-17 -2.00000000e+00]

[ 0.00000000e+00 1.00000000e+00 2.22044605e-16 6.21724894e-16

1.01506105e-16 -1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.00000000e+00 2.22044605e-16

-7.53365624e-17 -2.22044605e-16]

[ 0.00000000e+00 0.00000000e+00 6.53509205e-17 1.00000000e+00

2.77555756e-17 1.00000000e+00]

[ 0.00000000e+00 0.00000000e+00 1.78229783e-17 -4.51329795e-16

1.00000000e+00 2.00000000e+00]]

X: [[-2.00000000e+00]

[-1.00000000e+00]

[-2.22044605e-16]

[ 1.00000000e+00]

[ 2.00000000e+00]]

Solution of linear equations:

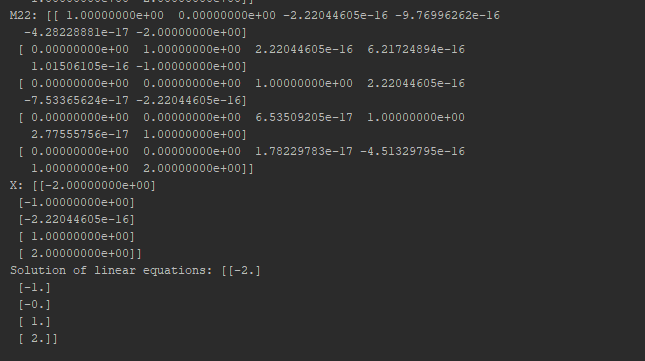
[[-2.]

[-1.]

[-0.]

[ 1.]

[ 2.]]



ب)



A = matrix\_maker()  
ns = null\_space(A)  
print("null space:", ns)  
dim\_ns = ns.shape  
print("dimension of null space:", dim\_ns)  
  
print("rank A:")  
print(matrix\_rank(A))

Enter the number of rows:2

Enter the number of columns:2

Enter the entries rowwise:

1 1

1 1

null space:

[[-0.70710678]

[ 0.70710678]]

dimension of null space: (2, 1)

input:

1 3 2 -4 3

-2 -1 2 6 4

0 -1 3 -5 1

3 -4 2 5 -7

1 2 -8 6 1

null space: []

dimension of null space: (5, 0)

rank A: 5

