In [7]:
```
%load_ext autoreload
```

Examen

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Fecha de Entrega: 23 de enero de 2025
Paralelo: GR1CC
Enlace de GitHub: https://github.com/alexis-bautista/Participacion-11-12-MN/blob/main/determinante.ipynb

Determinante

In [8]:
```
%autoreload 2
from src import (
    eliminacion_gaussiana,
    descomposicion_LU,
    resolver_LU,
    matriz_aumentada,
    separar_m_aumentada,
)


# ########################################################################
def calc_determinante(A: list[list[float]]) -> float:
    """Función que calcula el determinante usando el método...
    [Descomposición LU, eliminación gaussiana, Gauss-Jordan, Gauss-Jacobi o Gaus

    ## Parameters
    ``A``: Matriz cuadrada de tamaño n x n

    ## Return
    ``detA``: Determinante de la matriz A

    """
    # completar
    return
```

Ejercicio 1

In [9]:
```
A1 = [
    [-4, 2, -4, -4, 1, 2, 5, 3, 5, 1],
    [1, 0, 4, 3, 0, -2, 3, 0, 1, 5],
    [5, 5, -4, 5, -4, 2, 2, 2, 4, 4],
    [-1, 3, 4, -1, -4, 0, 5, 0, 0, 5],
    [4, 1, 4, 2, 0, 0, 3, -1, 0, 2],
    [2, -2, 1, -1, -2, -3, 2, -2, 4, -1],
    [3, -2, -3, -2, -1, -3, 5, -1, 5, 0],
    [3, 4, -3, 3, -2, 2, -4, -4, 1, 5],
    [-4, 0, 3, 3, -3, -2, -2, 0, 5, -4],
    [-2, 4, 4, -2, -1, 1, 5, -1, 3, -3],
```

```
]
calc_determinante(A1)
```

Ejercicio 2

In [10]:
```
A2 = [
    [2, 2, 4, 5, -2, -3, 2, -2],
    [-1, -1, 3, 2, 1, 1, -4, 4],
    [2, 5, -3, -3, -2, 2, 5, 3],
    [-2, -4, 0, 1, -1, 5, -4, -1],
    [1, -2, -1, 5, 5, 2, 1, -2],
    [5, 4, 0, 3, 4, -1, -3, -2],
    [4, -4, 1, 2, 3, 3, -1, 3],
    [-2, 1, -3, 0, 5, 4, 4, -4],
]
calc_determinante(A2)
```

Modificaciones

Conocemos que al triangular una matriz mediante eliminación gaussiana, el determinante es el producto de los elementos de la diagonal de la matriz triangular superior. Por ello para calcular el determinante de la matriz A usamos la matriz ampliada y la eliminacion gaussiana. Además, se debe tener en cuenta si hubo intercambios de filas, ya que cada intercambio cambia el signo del determinante.

In [45]:
```
from src import eliminacion_gaussiana, matriz_aumentada
import numpy as np

def calc_determinante(A: list[list[float]]) -> float:
    """Función que calcula el determinante usando el método de eliminación gauss

    ## Parameters
    ``A``: Matriz cuadrada de tamaño n x n

    ## Return
    ``detA``: Determinante de la matriz A

    """

    A = np.array(A, dtype=float)
    n = A.shape[0]

    # Comprobamos que la matriz sea cuadrada
    assert A.shape[0] == A.shape[1], "La matriz A debe ser cuadrada."

    # Crear una columna de ceros para podeer crear la matriz aumentada
    b = np.zeros(n)

    # Creamos la matriz aumentada
    Ab = matriz_aumentada(A, b)

    # Aplicamos eliminación gaussiana
    eliminacion_gaussiana(Ab)
```

```
    # Multiplicamos los elementos diagonales para obtener el determinante
    detA = 1
    for i in range(n):
        detA *= Ab[i, i]

    #consideramos los cambios de signo si se realizaron intercambios de filas
    signos = 1
    for i in range(n):
        if Ab[i, i] < 0:
            signos *= -1
    detA = detA * signos

    print ("\n El determinante de la matriz es: ", detA)

    #return detA
```

In [46]:
```
calc_determinante(A1)
```

```
[01-23 19:23:49][INFO]
[[  1.   0.   4.   3.   0.  -2.   3.   0.   1.   5.   0.]
 [  0.   2.  12.   8.   1.  -6.  17.   3.   9.  21.   0.]
 [  0.   5. -24. -10.  -4.  12. -13.   2.  -1. -21.   0.]
 [  0.   3.   8.   2.  -4.  -2.   8.   0.   1.  10.   0.]
 [  0.   1. -12. -10.   0.   8.  -9.  -1.  -4. -18.   0.]
 [  0.  -2.  -7.  -7.  -2.   1.  -4.  -2.   2. -11.   0.]
 [  0.  -2. -15. -11.  -1.   3.  -4.  -1.   2. -15.   0.]
 [  0.   4. -15.  -6.  -2.   8. -13.  -4.  -2. -10.   0.]
 [  0.   0.  19.  15.  -3. -10.  10.   0.   9.  16.   0.]
 [  0.   4.  12.   4.  -1.  -3.  11.  -1.   5.   7.   0.]]
[01-23 19:23:49][INFO]
[[  1.   0.   4.   3.   0.  -2.   3.   0.   1.   5.   0.]
 [  0.   1. -12. -10.   0.   8.  -9.  -1.  -4. -18.   0.]
 [  0.   0.  36.  40.  -4. -28.  32.   7.  19.  69.   0.]
 [  0.   0.  44.  32.  -4. -26.  35.   3.  13.  64.   0.]
 [  0.   0.  36.  28.   1. -22.  35.   5.  17.  57.   0.]
 [  0.   0. -31. -27.  -2.  17. -22.  -4.  -6. -47.   0.]
 [  0.   0. -39. -31.  -1.  19. -22.  -3.  -6. -51.   0.]
 [  0.   0.  33.  34.  -2. -24.  23.   0.  14.  62.   0.]
 [  0.   0.  19.  15.  -3. -10.  10.   0.   9.  16.   0.]
 [  0.   0.  60.  44.  -1. -35.  47.   3.  21.  79.   0.]]
[01-23 19:23:49][INFO]
[[  1.           0.           4.           3.           0.
   -2.           3.           0.           1.           5.
    0.        ]
 [  0.           1.         -12.         -10.           0.
    8.          -9.          -1.          -4.         -18.
    0.        ]
 [  0.           0.          19.          15.          -3.
  -10.          10.           0.           9.          16.
    0.        ]
 [  0.           0.           0.          -2.73684211   2.94736842
   -2.84210526  11.84210526   3.          -7.84210526  26.94736842
    0.        ]
 [  0.           0.           0.          -0.42105263   6.68421053
   -3.05263158  16.05263158   5.          -0.05263158  26.68421053
    0.        ]
 [  0.           0.           0.          -2.52631579  -6.89473684
    0.68421053  -5.68421053  -4.           8.68421053 -20.89473684
    0.        ]
 [  0.           0.           0.          -0.21052632  -7.15789474
   -1.52631579  -1.47368421  -3.          12.47368421 -18.15789474
    0.        ]
 [  0.           0.           0.           7.94736842   3.21052632
   -6.63157895   5.63157895   0.          -1.63157895  34.21052632
    0.        ]
 [  0.           0.           0.          11.57894737   1.68421053
   -9.05263158  13.05263158   7.           1.94736842  38.68421053
    0.        ]
 [  0.           0.           0.          -3.36842105   8.47368421
   -3.42105263  15.42105263   3.          -7.42105263  28.47368421
    0.        ]]
[01-23 19:23:49][INFO]
[[ 1.00000000e+00  0.00000000e+00  4.00000000e+00  3.00000000e+00
   0.00000000e+00 -2.00000000e+00  3.00000000e+00  0.00000000e+00
   1.00000000e+00  5.00000000e+00  0.00000000e+00]
 [ 0.00000000e+00  1.00000000e+00 -1.20000000e+01 -1.00000000e+01
   0.00000000e+00  8.00000000e+00 -9.00000000e+00 -1.00000000e+00
  -4.00000000e+00 -1.80000000e+01  0.00000000e+00]
```

```
 [ 0.00000000e+00  0.00000000e+00  1.90000000e+01  1.50000000e+01
  -3.00000000e+00 -1.00000000e+01  1.00000000e+01  0.00000000e+00
   9.00000000e+00  1.60000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00 -2.10526316e-01
  -7.15789474e+00 -1.52631579e+00 -1.47368421e+00 -3.00000000e+00
   1.24736842e+01 -1.81578947e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   2.10000000e+01  0.00000000e+00  1.90000000e+01  1.10000000e+01
  -2.50000000e+01  6.30000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   7.90000000e+01  1.90000000e+01  1.20000000e+01  3.20000000e+01
  -1.41000000e+02  1.97000000e+02  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   9.60000000e+01  1.70000000e+01  3.10000000e+01  4.20000000e+01
  -1.70000000e+02  2.63000000e+02  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  8.88178420e-16
  -2.67000000e+02 -6.42500000e+01 -5.00000000e+01 -1.13250000e+02
   4.69250000e+02 -6.51250000e+02  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
  -3.92000000e+02 -9.30000000e+01 -6.80000000e+01 -1.58000000e+02
   6.88000000e+02 -9.60000000e+02  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   1.23000000e+02  2.10000000e+01  3.90000000e+01  5.10000000e+01
  -2.07000000e+02  3.19000000e+02  0.00000000e+00]]
[01-23 19:23:49][INFO]
[[ 1.00000000e+00  0.00000000e+00  4.00000000e+00  3.00000000e+00
   0.00000000e+00 -2.00000000e+00  3.00000000e+00  0.00000000e+00
   1.00000000e+00  5.00000000e+00  0.00000000e+00]
 [ 0.00000000e+00  1.00000000e+00 -1.20000000e+01 -1.00000000e+01
   0.00000000e+00  8.00000000e+00 -9.00000000e+00 -1.00000000e+00
  -4.00000000e+00 -1.80000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.90000000e+01  1.50000000e+01
  -3.00000000e+00 -1.00000000e+01  1.00000000e+01  0.00000000e+00
   9.00000000e+00  1.60000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00 -2.10526316e-01
  -7.15789474e+00 -1.52631579e+00 -1.47368421e+00 -3.00000000e+00
   1.24736842e+01 -1.81578947e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   2.10000000e+01  0.00000000e+00  1.90000000e+01  1.10000000e+01
  -2.50000000e+01  6.30000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.90000000e+01 -5.94761905e+01 -9.38095238e+00
  -4.69523810e+01 -4.00000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.70000000e+01 -5.58571429e+01 -8.28571429e+00
  -5.57142857e+01 -2.50000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  8.88178420e-16
   0.00000000e+00 -6.42500000e+01  1.91571429e+02  2.66071429e+01
   1.51392857e+02  1.49750000e+02  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00 -9.30000000e+01  2.86666667e+02  4.73333333e+01
   2.21333333e+02  2.16000000e+02  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   0.00000000e+00  2.10000000e+01 -7.22857143e+01 -1.34285714e+01
  -6.05714286e+01 -5.00000000e+01  0.00000000e+00]]
[01-23 19:23:49][INFO]
[[ 1.00000000e+00  0.00000000e+00  4.00000000e+00  3.00000000e+00
   0.00000000e+00 -2.00000000e+00  3.00000000e+00  0.00000000e+00
   1.00000000e+00  5.00000000e+00  0.00000000e+00]
 [ 0.00000000e+00  1.00000000e+00 -1.20000000e+01 -1.00000000e+01
```

```
   0.00000000e+00  8.00000000e+00 -9.00000000e+00 -1.00000000e+00
  -4.00000000e+00 -1.80000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.90000000e+01  1.50000000e+01
  -3.00000000e+00 -1.00000000e+01  1.00000000e+01  0.00000000e+00
   9.00000000e+00  1.60000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00 -2.10526316e-01
  -7.15789474e+00 -1.52631579e+00 -1.47368421e+00 -3.00000000e+00
   1.24736842e+01 -1.81578947e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   2.10000000e+01  0.00000000e+00  1.90000000e+01  1.10000000e+01
  -2.50000000e+01  6.30000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.70000000e+01 -5.58571429e+01 -8.28571429e+00
  -5.57142857e+01 -2.50000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  2.95238095e+00 -1.20448179e-01
   1.53165266e+01 -1.20588235e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  8.88178420e-16
   0.00000000e+00  0.00000000e+00 -1.95357143e+01 -4.70798319e+00
  -5.91743697e+01  5.52647059e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00 -1.89047619e+01  2.00560224e+00
  -8.34565826e+01  7.92352941e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   0.00000000e+00  0.00000000e+00 -3.28571429e+00 -3.19327731e+00
   8.25210084e+00 -1.91176471e+01  0.00000000e+00]]
[01-23 19:23:49][INFO]
[[ 1.00000000e+00  0.00000000e+00  4.00000000e+00  3.00000000e+00
   0.00000000e+00 -2.00000000e+00  3.00000000e+00  0.00000000e+00
   1.00000000e+00  5.00000000e+00  0.00000000e+00]
 [ 0.00000000e+00  1.00000000e+00 -1.20000000e+01 -1.00000000e+01
   0.00000000e+00  8.00000000e+00 -9.00000000e+00 -1.00000000e+00
  -4.00000000e+00 -1.80000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.90000000e+01  1.50000000e+01
  -3.00000000e+00 -1.00000000e+01  1.00000000e+01  0.00000000e+00
   9.00000000e+00  1.60000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00 -2.10526316e-01
  -7.15789474e+00 -1.52631579e+00 -1.47368421e+00 -3.00000000e+00
   1.24736842e+01 -1.81578947e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   2.10000000e+01  0.00000000e+00  1.90000000e+01  1.10000000e+01
  -2.50000000e+01  6.30000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.70000000e+01 -5.58571429e+01 -8.28571429e+00
  -5.57142857e+01 -2.50000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  2.95238095e+00 -1.20448179e-01
   1.53165266e+01 -1.20588235e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  8.88178420e-16
   0.00000000e+00  0.00000000e+00  0.00000000e+00 -5.50498102e+00
   4.21740987e+01 -2.45277514e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  0.00000000e+00  1.23434535e+00
   1.46185958e+01  2.01992410e+00  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   0.00000000e+00  0.00000000e+00  4.44089210e-16 -3.32732448e+00
   2.52979127e+01 -3.25379507e+01  0.00000000e+00]]
[01-23 19:23:49][INFO]
[[ 1.00000000e+00  0.00000000e+00  4.00000000e+00  3.00000000e+00
   0.00000000e+00 -2.00000000e+00  3.00000000e+00  0.00000000e+00
```

```
   1.00000000e+00  5.00000000e+00  0.00000000e+00]
 [ 0.00000000e+00  1.00000000e+00 -1.20000000e+01 -1.00000000e+01
   0.00000000e+00  8.00000000e+00 -9.00000000e+00 -1.00000000e+00
  -4.00000000e+00 -1.80000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.90000000e+01  1.50000000e+01
  -3.00000000e+00 -1.00000000e+01  1.00000000e+01  0.00000000e+00
   9.00000000e+00  1.60000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00 -2.10526316e-01
  -7.15789474e+00 -1.52631579e+00 -1.47368421e+00 -3.00000000e+00
   1.24736842e+01 -1.81578947e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   2.10000000e+01  0.00000000e+00  1.90000000e+01  1.10000000e+01
  -2.50000000e+01  6.30000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.70000000e+01 -5.58571429e+01 -8.28571429e+00
  -5.57142857e+01 -2.50000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  2.95238095e+00 -1.20448179e-01
   1.53165266e+01 -1.20588235e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  0.00000000e+00  1.23434535e+00
   1.46185958e+01  2.01992410e+00  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  8.88178420e-16
   0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   1.07370676e+02 -1.55192160e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   0.00000000e+00  0.00000000e+00  4.44089210e-16  0.00000000e+00
   6.47040738e+01 -2.70930054e+01  0.00000000e+00]]
[01-23 19:23:49][INFO]
[[ 1.00000000e+00  0.00000000e+00  4.00000000e+00  3.00000000e+00
   0.00000000e+00 -2.00000000e+00  3.00000000e+00  0.00000000e+00
   1.00000000e+00  5.00000000e+00  0.00000000e+00]
 [ 0.00000000e+00  1.00000000e+00 -1.20000000e+01 -1.00000000e+01
   0.00000000e+00  8.00000000e+00 -9.00000000e+00 -1.00000000e+00
  -4.00000000e+00 -1.80000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.90000000e+01  1.50000000e+01
  -3.00000000e+00 -1.00000000e+01  1.00000000e+01  0.00000000e+00
   9.00000000e+00  1.60000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00 -2.10526316e-01
  -7.15789474e+00 -1.52631579e+00 -1.47368421e+00 -3.00000000e+00
   1.24736842e+01 -1.81578947e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   2.10000000e+01  0.00000000e+00  1.90000000e+01  1.10000000e+01
  -2.50000000e+01  6.30000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.70000000e+01 -5.58571429e+01 -8.28571429e+00
  -5.57142857e+01 -2.50000000e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  2.95238095e+00 -1.20448179e-01
   1.53165266e+01 -1.20588235e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  0.00000000e+00  1.23434535e+00
   1.46185958e+01  2.01992410e+00  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   0.00000000e+00  0.00000000e+00  4.44089210e-16  0.00000000e+00
   6.47040738e+01 -2.70930054e+01  0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  8.88178420e-16
   0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  2.94392255e+01  0.00000000e+00]]
```

```
El determinante de la matriz es:  9912775.999999994
```

Luego de aplicar la eliminacion gaussiana y multiplicar los elementos de la diagonal obtuvimo que el determinante de la matriz A_1 es 9912776 lo que quiere decir que el sistema de ecuaciones tiene una solucion unica

In [47]:
```
calc_determinante(A2)
```

```
[01-23 19:25:43][INFO]
[[ -1.  -1.   3.   2.   1.   1.  -4.   4.   0.]
 [  0.   0.  10.   9.   0.  -1.  -6.   6.   0.]
 [  0.   3.   3.   1.   0.   4.  -3.  11.   0.]
 [  0.  -2.  -6.  -3.  -3.   3.   4.  -9.   0.]
 [  0.  -3.   2.   7.   6.   3.  -3.   2.   0.]
 [  0.  -1.  15.  13.   9.   4. -23.  18.   0.]
 [  0.  -8.  13.  10.   7.   7. -17.  19.   0.]
 [  0.   3.  -9.  -4.   3.   2.  12. -12.   0.]]
[01-23 19:25:43][INFO]
[[  -1.   -1.    3.    2.    1.    1.   -4.    4.    0.]
 [   0.   -1.   15.   13.    9.    4.  -23.   18.    0.]
 [   0.    0.   48.   40.   27.   16.  -72.   65.    0.]
 [   0.    0.  -36.  -29.  -21.   -5.   50.  -45.    0.]
 [   0.    0.  -43.  -32.  -21.   -9.   66.  -52.    0.]
 [   0.    0.   10.    9.    0.   -1.   -6.    6.    0.]
 [   0.    0. -107.  -94.  -65.  -25.  167. -125.    0.]
 [   0.    0.   36.   35.   30.   14.  -57.   42.    0.]]
[01-23 19:25:43][INFO]
[[ -1.   -1.    3.    2.    1.    1.   -4.    4.    0. ]
 [  0.   -1.   15.   13.    9.    4.  -23.   18.    0. ]
 [  0.    0.   10.    9.    0.   -1.   -6.    6.    0. ]
 [  0.    0.    0.    3.4 -21.   -8.6  28.4 -23.4   0. ]
 [  0.    0.    0.    6.7 -21.  -13.3  40.2 -26.2   0. ]
 [  0.    0.    0.   -3.2  27.   20.8 -43.2  36.2   0. ]
 [  0.    0.    0.    2.3 -65.  -35.7 102.8 -60.8   0. ]
 [  0.    0.    0.    2.6  30.   17.6 -35.4  20.4   0. ]]
[01-23 19:25:43][INFO]
[[  -1.   -1.    3.    2.    1.    1.   -4.    4.    0.]
 [   0.   -1.   15.   13.    9.    4.  -23.   18.    0.]
 [   0.    0.   48.   40.   27.   16.  -72.   65.    0.]
 [   0.    0.  -36.  -29.  -21.   -5.   50.  -45.    0.]
 [   0.    0.  -43.  -32.  -21.   -9.   66.  -52.    0.]
 [   0.    0.   10.    9.    0.   -1.   -6.    6.    0.]
 [   0.    0. -107.  -94.  -65.  -25.  167. -125.    0.]
 [   0.    0.   36.   35.   30.   14.  -57.   42.    0.]]
[01-23 19:25:43][INFO]
[[ -1.   -1.    3.    2.    1.    1.   -4.    4.    0. ]
 [  0.   -1.   15.   13.    9.    4.  -23.   18.    0. ]
 [  0.    0.   10.    9.    0.   -1.   -6.    6.    0. ]
 [  0.    0.    0.    3.4 -21.   -8.6  28.4 -23.4   0. ]
 [  0.    0.    0.    6.7 -21.  -13.3  40.2 -26.2   0. ]
 [  0.    0.    0.   -3.2  27.   20.8 -43.2  36.2   0. ]
 [  0.    0.    0.    2.3 -65.  -35.7 102.8 -60.8   0. ]
 [  0.    0.    0.    2.6  30.   17.6 -35.4  20.4   0. ]]
[01-23 19:25:43][INFO]
[[-1.00000000e+00 -1.00000000e+00  3.00000000e+00  2.00000000e+00
   1.00000000e+00  1.00000000e+00 -4.00000000e+00  4.00000000e+00
   0.00000000e+00]
 [ 0.00000000e+00 -1.00000000e+00  1.50000000e+01  1.30000000e+01
   9.00000000e+00  4.00000000e+00 -2.30000000e+01  1.80000000e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.00000000e+01  9.00000000e+00
   0.00000000e+00 -1.00000000e+00 -6.00000000e+00  6.00000000e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  2.30000000e+00
  -6.50000000e+01 -3.57000000e+01  1.02800000e+02 -6.08000000e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   1.68347826e+02  9.06956522e+01 -2.59260870e+02  1.50913043e+02
```

```
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
  -6.34347826e+01 -2.88695652e+01  9.98260870e+01 -4.83913043e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   7.50869565e+01  4.41739130e+01 -1.23565217e+02  6.64782609e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   1.03478261e+02  5.79565217e+01 -1.51608696e+02  8.91304348e+01
   0.00000000e+00]]
[01-23 19:25:43][INFO]
[[-1.00000000e+00 -1.00000000e+00  3.00000000e+00  2.00000000e+00
   1.00000000e+00  1.00000000e+00 -4.00000000e+00  4.00000000e+00
   0.00000000e+00]
 [ 0.00000000e+00 -1.00000000e+00  1.50000000e+01  1.30000000e+01
   9.00000000e+00  4.00000000e+00 -2.30000000e+01  1.80000000e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.00000000e+01  9.00000000e+00
   0.00000000e+00 -1.00000000e+00 -6.00000000e+00  6.00000000e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  2.30000000e+00
  -6.50000000e+01 -3.57000000e+01  1.02800000e+02 -6.08000000e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
  -6.34347826e+01 -2.88695652e+01  9.98260870e+01 -4.83913043e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.40795065e+01  5.66483893e+00  2.24886909e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.00013708e+01 -5.40233036e+00  9.19808088e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   0.00000000e+00  1.08629198e+01  1.12330363e+01  1.01919123e+01
   0.00000000e+00]]
[01-23 19:25:43][INFO]
[[-1.00000000e+00 -1.00000000e+00  3.00000000e+00  2.00000000e+00
   1.00000000e+00  1.00000000e+00 -4.00000000e+00  4.00000000e+00
   0.00000000e+00]
 [ 0.00000000e+00 -1.00000000e+00  1.50000000e+01  1.30000000e+01
   9.00000000e+00  4.00000000e+00 -2.30000000e+01  1.80000000e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.00000000e+01  9.00000000e+00
   0.00000000e+00 -1.00000000e+00 -6.00000000e+00  6.00000000e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  2.30000000e+00
  -6.50000000e+01 -3.57000000e+01  1.02800000e+02 -6.08000000e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
  -6.34347826e+01 -2.88695652e+01  9.98260870e+01 -4.83913043e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.00013708e+01 -5.40233036e+00  9.19808088e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  1.32700110e+01  9.54002193e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   0.00000000e+00  1.77635684e-15  1.71007401e+01  2.01480263e-01
   0.00000000e+00]]
```

```
[01-23 19:25:43][INFO]
[[-1.00000000e+00 -1.00000000e+00  3.00000000e+00  2.00000000e+00
   1.00000000e+00  1.00000000e+00 -4.00000000e+00  4.00000000e+00
   0.00000000e+00]
 [ 0.00000000e+00 -1.00000000e+00  1.50000000e+01  1.30000000e+01
   9.00000000e+00  4.00000000e+00 -2.30000000e+01  1.80000000e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  1.00000000e+01  9.00000000e+00
   0.00000000e+00 -1.00000000e+00 -6.00000000e+00  6.00000000e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  2.30000000e+00
  -6.50000000e+01 -3.57000000e+01  1.02800000e+02 -6.08000000e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
  -6.34347826e+01 -2.88695652e+01  9.98260870e+01 -4.83913043e+01
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  1.00013708e+01 -5.40233036e+00  9.19808088e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
   0.00000000e+00  0.00000000e+00  1.32700110e+01  9.54002193e+00
   0.00000000e+00]
 [ 0.00000000e+00  0.00000000e+00  0.00000000e+00  4.44089210e-16
   0.00000000e+00  1.77635684e-15  0.00000000e+00 -1.20925138e+01
   0.00000000e+00]]

El determinante de la matriz es:  2341545.999999993
```

Luego de aplicar la eliminacion gaussiana y multiplicar los elementos de la diagonal obtuvimo que el determinante de la matriz A_2 es 2341546 lo que quiere decir que el sistema de ecuaciones tiene una solucion unica