Q3. Singular Value Decomposition (SVD):

Perform Singular Value Decomposition on the matrix A obtained in Question 2. Separate and print matrices U, Σ, and .Verify that A equals the product of U, Σ, and VV.Additionally, find the rank 2 and rank 3 approximations of matrix A

In [2]:
```
import numpy as np
import sympy as sp
matrix_A = np.array([[5,5,4,7,2],
                     [5,1,3,9,7],
                     [7,1,1,3,2],
                     [2,4,4,6,0],
                     [6,0,7,4,2]])
print("Matrix A:")
sp.Matrix(matrix_A)
```

```
Matrix A:
```

Out[2]:
$$\begin{bmatrix} 5 & 5 & 4 & 7 & 2 \\ 5 & 1 & 3 & 9 & 7 \\ 7 & 1 & 1 & 3 & 2 \\ 2 & 4 & 4 & 6 & 0 \\ 6 & 0 & 7 & 4 & 2 \end{bmatrix}$$

In [4]:
```
U, Sigma, Vt = np.linalg.svd(matrix_A)
Sigma_matrix = np.diag(Sigma)
rank2approximation = U[:, :2] @ Sigma_matrix[:2, :2] @ Vt[:2, :]
rank3approximation = U[:, :3] @ Sigma_matrix[:3, :3] @ Vt[:3, :]
print("\nRank 2 Approximation of Matrix A:")
sp.Matrix(rank2approximation)
```

```
Rank 2 Approximation of Matrix A:
```

Out[4]:
$$\begin{bmatrix} 4.44426552383022 & 4.07595662432027 & 4.93195369758656 & 7.262226553(\\ 7.36028374084743 & 1.02882305752662 & 4.17747833334852 & 7.2003983042 \\ 4.56648708730857 & -0.0174263709492994 & 2.13445950325304 & 3.9140987685 \\ 2.24645608255317 & 4.33107531235087 & 4.07674140517855 & 5.5865547595 \\ 5.1578753574221 & 1.51164305670478 & 3.47891545825589 & 5.7128643893 \end{bmatrix}$$

In [5]:
```
print("\nRank 3 Approximation of Matrix A:")
sp.Matrix(rank3approximation)
```

```
Rank 3 Approximation of Matrix A:
```

Out[5]:

$$\begin{bmatrix} 4.28998455200343 & 4.12218566613625 & 4.76258870707172 & 7.409577843020 \\ 5.62701474289532 & 1.5481830540052 & 2.27474798415537 & 8.855815817966 \\ 5.33310295581208 & -0.24713659783089 & 2.97602724657398 & 3.181916206856 \\ 2.11347445931426 & 4.37092217712413 & 3.93075819615526 & 5.713563382222 \\ 7.14338536503089 & 0.916701087640397 & 5.65854836842021 & 3.816535519358 \end{bmatrix}$$

In [ ]: