🔢 Matrix Operations in Python

We will perform:

1. Matrix Addition
2. Matrix Subtraction
3. Matrix Multiplication
4. Transpose of a Matrix

👉 First without `math` library (manual implementation), then with libraries (`numpy`).

```
# Matrix Addition, Subtraction, Multiplication without math

# Define matrices as lists of lists
A = [[1, 2, 3],
     [4, 5, 6]]

B = [[7, 8, 9],
     [10, 11, 12]]

print("Matrix A:", A)
print("Matrix B:", B)
```

```
# Addition
result_add = [[A[i][j] + B[i][j] for j in range(len(A[0]))] for i in range(len(A))]
print("Addition:\n", result_add)
```

```
# Subtraction
result_sub = [[A[i][j] - B[i][j] for j in range(len(A[0]))] for i in range(len(A))]
print("Subtraction:\n", result_sub)
```

```
# Multiplication (Matrix product)
# A: m x n, B: n x p
A = [[1, 2],
     [3, 4],
     [5, 6]]

B = [[7, 8, 9],
     [10, 11, 12]]

result_mul = [[0 for _ in range(len(B[0]))] for _ in range(len(A))]

for i in range(len(A)):      # rows of A
    for j in range(len(B[0])):  # cols of B
        for k in range(len(B)): # cols of A / rows of B
            result_mul[i][j] += A[i][k] * B[k][j]

print("Multiplication:\n", result_mul)
```

```
# Transpose
A = [[1, 2, 3],
     [4, 5, 6]]

transpose = [[A[j][i] for j in range(len(A))] for i in range(len(A[0]))]
print("Transpose of A:\n", transpose)
```

🔷 2. Matrix Operations With numpy Library

- Although you asked about math, the math library doesn’t directly support matrices.
- For matrix operations, numpy is the standard library in Python.

```
import numpy as np

# Define matrices
A = np.array([[1, 2, 3],
              [4, 5, 6]])
```

```
B = np.array([[7, 8, 9],
              [10, 11, 12]])

print("Matrix A:\n", A)
print("Matrix B:\n", B)
```

```
# Addition
print("Addition:\n", A + B)

# Subtraction
print("Subtraction:\n", A - B)
```

```
# Multiplication (element-wise)
print("Element-wise Multiplication:\n", A * B)

# Matrix Product
print("Matrix Product:\n", np.dot(A, B.T))   # Using dot product
```

```
# Transpose
print("Transpose of A:\n", A.T)
```

```
# 🎯 Summary

| Operation       | Without Library (manual) | With numpy |
|-----------------|--------------------------|------------|
| Addition        | Nested loops/list comp. | `A + B` |
| Subtraction     | Nested loops/list comp. | `A - B` |
| Multiplication  | Triple loop             | `np.dot(A, B)` |
| Transpose       | List comprehension       | `A.T` |

👉 For learning: manual implementation is good.
👉 For real projects: always use `numpy` for speed & simplicity.
```