

# Matrix Arithmetic Operations in MATLAB

## 1 Introduction

In MATLAB, matrices are first-class objects, and arithmetic operations can be performed using matrix algebra rules or element-wise operations. Below are the most common operations with examples.

## 2 Addition and Subtraction

Matrices must have the same dimensions.

```
A = [1 2 3; 4 5 6];  
B = [6 5 4; 3 2 1];
```

```
C_add = A + B    % Addition  
C_sub = A - B    % Subtraction
```

## 3 Matrix Multiplication (\*)

Matrix multiplication follows linear algebra rules: if  $A$  is  $m \times n$  and  $B$  is  $n \times p$ , then  $A * B$  is  $m \times p$ .

```
A = [1 2; 3 4; 5 6];    % 3x2  
B = [7 8 9; 10 11 12]; % 2x3
```

```
C_mul = A * B    % Result: 3x3
```

## 4 Element-wise Multiplication (.\*)

Multiplies corresponding elements of two matrices of the same size.

```
A = [1 2 3; 4 5 6];  
B = [6 5 4; 3 2 1];
```

```
C_elem_mul = A .* B
```

## 5 Matrix Division

### 5.1 Right Division (/)

$A/B$  means  $A \cdot B^{-1}$ .

```
A = [3 4; 2 5];
```

```
B = [1 2; 3 4];
```

```
C_right = A / B
```

### 5.2 Left Division (\)

$A \backslash B$  means  $A^{-1} \cdot B$ .

```
C_left = A \ B
```

## 6 Element-wise Division (./ and .\)

```
A = [10 20 30; 40 50 60];
```

```
B = [2 4 5; 8 10 15];
```

```
C_elem_right = A ./ B    % Right element-wise division
```

```
C_elem_left  = A .\ B    % Left element-wise division (B./A)
```

## 7 Power

### 7.1 Matrix Power (^)

Only valid for square matrices; raises the matrix to an integer power.

```
A = [2 0; 0 3];
```

```
M_pow  = A ^ 2
```

### 7.2 Element-wise Power (.^)

Raises each element of a matrix to the given power individually.

```
E_pow  = A .^ 2
```

## 8 Scalar Operations

Scalars operate element-wise by default.

```
A = [1 2 3; 4 5 6];
```

```
A_plus_scalar = A + 10
```

```
A_times_scalar = A * 5
```

```
A_div_scalar = A / 2
```

```
A_pow_scalar = A .^ 3
```