



MatLAB

Lecture 2

Engineering Concepts and
Methods



Outline

- Math and Trigonometric Functions
- Data Analysis Functions
- Matrix Operations
- Solutions to Systems of Linear Equations



MATLAB Help feature

- To get help on a particular topic, type *help <topic>* in the command window
 - Example: help sin
 - help sqrt
- MATLAB will display what that function does, how many argument(s) it needs, and the names of similar functions



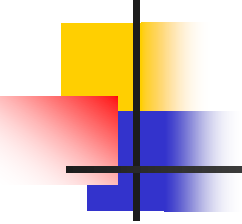
Math and Trigonometric Functions

- Elementary math functions:
 - `abs(x)`
 - `sqrt(x)`
 - `round(x)`
 - `exp(x)`
 - `log(x)` is natural log i.e. $\ln(x)$; `log10(x)` is $\log_{10}(x)$
- Trigonometric functions:
 - `sin(x)`, x in radians
 - `cos(x)`;
 - `acos(x)`, x must be a number between 1 and -1



Data Analysis Functions

- Functions used to evaluate a set of test data:
 - ***max(x)***: returns the largest value in a vector x . Returns a row vector containing the maximum element from each column of a matrix x .
 - ***max(x,y)***: Returns a matrix. Each element in the matrix contains the maximum value from the corresponding positions in x and y .
 - ***min(x); min(x,y)***



$x = [2, 10, 34, 23];$
 $\max(x) = 34$

$y = [12, 26, 21, 13];$
 $\max(x,y) = 12 \ 26 \ 34 \ 23$

$\min(x) = 2$
 $\min(x,y) = 2 \ 10 \ 21 \ 13$



Data Analysis Functions

- **Mean(x)**: computes the average value of the elements in a vector x or computes the mean value of each column of a matrix x .
- **median(x)**: computes the median value of the elements in a vector x or computes the median value of each column of a matrix x .
- **std(x)**: computes the standard deviation of the values in a vector x or computes the standard deviation of each column of matrix x .



Data Analysis Functions

- **sum(x)** : sum of the elements of vector x
- **prod(x)**: product of elements of vector x
- **sort(x)** : sorts the elements of vector x into ascending order
- **size(x)** : determines the number of rows and columns of matrix x
- **length(x)**: determines the largest dimension of matrix x



Special values & functions

- `pi` : π
- `i, j` : imaginary number
- `Inf` : infinity, divide by zero
- `NaN` : not-a-number, divide zero by zero
- `clock`: display current year, month, day, hour, minute and seconds
- `date`: current date 02-Nov-2005



Colon Operator

- Use to define a range (like .. In MathCAD)
- $A = 1:5$
 - Means $A = 1, 2, 3, 4, 5$
 - By default the increment is 1
- $A = 1:2:5$
 - The middle number is the increment
 - So, $A = 1, 3, 5$



More use of Colon Operator

- To represent an ENTIRE row or column
- To select a submatrix from another matrix.
Exp: $F = C(:,2)$
 - F will have the 2nd column of matrix C
 - : means all the rows of the chosen column
- To choose 2nd to 4th column, $B = C(:,2:4)$
- To choose 2nd row, $A = C(2,:)$
- To choose a single element, $D = C(2,3)$



Array operations

- If you want element-by-element operation for an array use .
 - $A.*B$ element-by-element multiplication
 - $A./B$ element-by-element division
 - $A.^3$ exponentiation of individual elements
 - But for addition and subtraction use $A+B$
 - To multiply or divide each elements of array A by a constant number use $2.5*A$



Matrix Operations and Functions

- Transpose: A'
- Power: $A^2 = A * A$
- Matrix Multiplication: $A * B$
 - Inner matrix dimension must agree.
 - $C_{2 \times 3} = A_{2 \times 3} * B_{3 \times 3}$
- Matrix Inverse: A^{-1} or $\text{inv}(A)$
- Determinant: $\text{det}(A)$
- Dot Product: $\text{dot}(A, B)$



Solutions to linear Equations

- Consider the following system:

- $3x+2y-z=10$
- $-x+3y+2z=5$
- $x-y-z=-1$

$$A = \begin{bmatrix} 3 & 2 & -1 \\ -1 & 3 & 2 \\ 1 & -1 & -1 \end{bmatrix} \quad B = \begin{bmatrix} 10 \\ 5 \\ -1 \end{bmatrix}$$

Solution using the **matrix inverse**: $X = \text{inv}(A) * B$

Solution using **matrix left division**: $X = A \setminus B$



Solutions to linear Equations

MATLAB

- $X = \text{inv}(A) * B$
- $X = A^{-1} * B$
- $X = A \setminus B$

MathCAD

- $X := [A]^{-1}.B$
- $X := \text{Isolve}(A,B)$



Random numbers

- `rand(n)`: returns an $n \times n$ matrix
- `rand(m,n)`: returns an $m \times n$ matrix



The M-FILE (another way to save your work)

- Enter Commands just like Command Window.
- Save comments, equations and variables
- Create programs and save.
- Run your M-File. (click on "*Debug/Run*")
 - Can also run from Command Window
- NOTE: You **CANNOT** see the results of your program here...
- The results will be written in the Command Window



Use m-file

- Calculate the range of a projectile using the following equation and display the results in a table

$$range = \frac{2V^2 \sin \theta \cos \theta}{g}$$

- $g = 9.81$; $\theta =$ launch angle = 0 to $\pi/2$
- V is the velocity of launch = 50



```
% range of a projectile
```

```
V = 50 ;
```

```
g = 9.81 ;
```

```
% launch angle in radian
```

```
theta = 0:pi/10:pi/2 ;
```

```
%convert radian to degree
```

```
degree = theta * 180/pi ;
```

```
% calculate range
```

```
range = 2 * V * V * sin(theta) .*cos(theta) / g ;
```

```
% create a table
```

```
table = [degree' , range' ]
```



Save the file as example.m

Command Window

```
>> example
```

```
table =
```

	0	0
18.0000	149.7924	
36.0000	242.3691	
54.0000	242.3691	
72.0000	149.7924	
90.0000	0.0000	

```
>>
```