

MatLab

* contents :

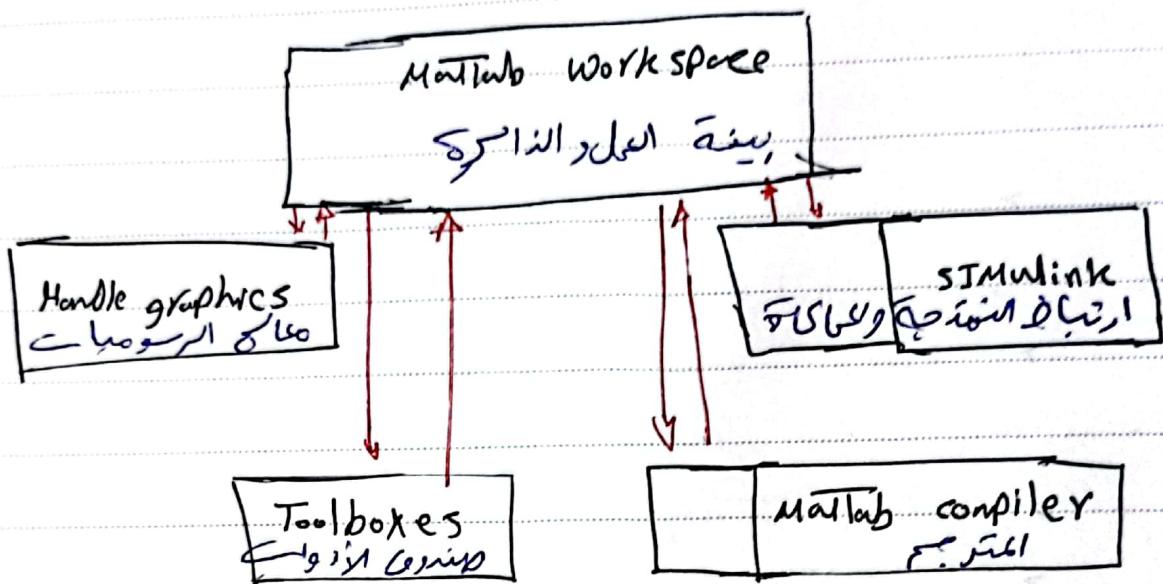
- ✓ 1- Introduction
- ✓ 2- Matrices
 - Numerical matrixes
- ✓ 3- Elementary Math
 - Math Function
- ✓ 4- Graphics Fundamentals
 - 2D plotting
 - 3D plotting
 - subplots
- 5- Script files
- 6- M-File programming
 - Flow control statements
- 7- MatLab simulink
- 8- Graphical user Interface (GUI)

For my extra information contact math Works

www.mathworks.com

التاريخ:

/ /

MatLab الجزء الرئيسي

* Computer Application in Design and production

→ Learning outcomes

1- understand what MATLAB is

2- know how to get started with Matlab

3- Recognize The basics of Matlab

4- know how to solve various problems

Be able to explore Matlab on your own!

→ Contents

+ introduction

2- Getting Started

3- vectors and Matrices

4- Built in Functions

5- M-files : script and Functions

introduction

MATLAB - Matrix Laboratory كل ما فيه جواه ماتركس او ماتريكس

1- initially developed by a lecturer in 1970's To help students learn linear algebra

matrix is an array ولديه مصفوفة او ماتريكس

2- it was later marketed and further developed under MathWorks Inc. (Founded in 1984) - www.mathworks.com

3- Matlab is a software package which can be used To perform analysis and solve mathematical and engineering problems.

4- it has excellent programming features and graphics capability - easy To learn and flexible

5- Available in many operating systems - Win, mac, unix, DOS

6- It has several Tool boxes To solve specific problems

————— Getting Started —————

Getting Started

Run MATLAB from Start → programs → MATLAB

- command history, command window, workspace, etc
For Matlab student - only command window

*Command window

Main window - where commands are entered

Rounding التتربي Lec-1

- ① Fix(a) % round (a) Toward Zero
 - ② Fix(a) % round (a) Toward - ∞
 - ③ Ceil(a) % round (a) Toward $+\infty$
 - ④ Round(a) % round (a) Toward To The near Integer
- Work space

any variable you entered in the command window will be stored in workspace "ans"

Command History

Any thing you worked it will appear in command history and its time

% BID Mas

Brackets - Power - Division -

Multiplication - Addition -

Subtraction

\gg Who

Your variables are:

ans

\gg Whoos

Name	Size	Bytes	Class	Attributes
ans	1x1	8	double	

\gg clear Ans

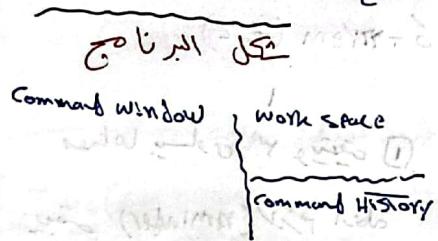
Clear workspace ans (Ans) يفتح المتنبر

\gg clc

Command window و لـ History workspace تفتح

\gg clear

Clear workspace C (all) يفتح البرنامـج



X = 6

X = 6 ; semi colon

\gg X = 6

window مفتوحة في

\gg sqrt(9) ans = 3

لوسادا اهل الجذر التربيعي

\gg d = sqrt(9) d = 3

\gg s = 8^(1/3)

\gg s = 16^(1/4)

لوساور اهل الجذر التكعيب او الرايـج

clear X

لـ سافر اـ

the workspace N

و مفتوح اـ

\gg log(100)

ans = 4.6052

\gg log 10 (100)

ans = 2

\gg log(100) = ln(100) انـ

\gg log 10(100) = log(100)

array Lec-2

• All variables are matrices

• All Matrix are array

و الماتريـس

Variables :-

1- They are case-sensitive $x \neq X$

2- Their names can contain up to 31 characters

3- Must start with a letter

"Variables are stored in workspace"

Matlab:-

يـمـكـنـكـ اـ

Notes:-

منـهـ كـاـبـيـهـ Preferences

commmand window

انـ

0.9000000

1 0.00000

% Vectors

command window

بطـ% قبل المـواـئـدـ

\gg X = [1 2 3 4] X = 1 2 3 4

\gg X = [1, 2, 3, 4] X = 1 2 3 4

عـلـمـانـ اـعـلـمـ بـيـتـةـ

space بـ () او اـعـلـمـ بـ () او variables

\gg Who

Your variable are x

\gg Whose

Name	Size	Bytes	Class	Attributes
X	1x4	32	double	*8

\gg Y = [1; 2; 3; 4;]

y =
1
2
3
4

\gg Who

Name	Size	Bytes	Class	Attributes
Y	4x1	32	double	

\gg Z = [1, 2, 3; 4, 5, 6]

z =
1 2 3
4 5 6

يـمـكـنـكـ اـ

spacel (or) ، بـ ()

\gg Who

Name	Size	Bytes	Class	Attributes
Z	2x3	48	double	2x3x8

$\Rightarrow X = \text{linspace}(0, 1, 6)$

0 0.2 0.4 0.6 0.8 1

$\Rightarrow Y = [X(2) \quad X(4)]$

0.2 0.6

$\Rightarrow X = [1 : 2 : 5]$

1 3 5

$\Rightarrow Y = \text{prod}(X)$

15

$\Rightarrow \text{length}(X)$

3

$\Rightarrow a = [1 \ 2 \ 3];$

$\Rightarrow b = [4 \ 5 \ 6];$

$\Rightarrow c = \text{cross}(a, b)$

$c = -3 \ 6 \ -3$

میز کے ساتھ اجڑا کر

$(1 \ 2 \ 3) * (4 \ 5 \ 6)$

$$\begin{array}{|ccc|} \hline & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ \hline \end{array} \rightarrow 0 = 0 + 0$$

$\vec{A} * \vec{B} = \checkmark$

$\Rightarrow d = \text{dot}(a, b)$

$d = 32$

میز کے ساتھ اجڑا کر
کوئی تغیرت نہیں
کیا

dimension

Relational operation

- A > B The result is true if A is greater than B, and is false otherwise
 - A < B The result is true if A is smaller than B, and is false otherwise
 - A >= B True if A is greater than or equal to B, false otherwise
 - A <= B True if A is smaller than or equal to B, false otherwise
 - A == B The result is true if A is equal to B, and is false otherwise
 - A ~= B The result is true if A is not equal to B, and is false otherwise
- □ Examples:
- >>a=5;b=2;
 - >>x=a>b; %x=1
 - >>x=(a~=b) %x=1
≠ case
- □ Note:
- Many users confuse the double equality sign (==) used in relational tests with the equality sign (=) used in assignments. When a user uses (=) instead of (==), Matlab usually reports that an expected relational operator wasn't found.

Logical operation

- The general form of a binary logic operation: $b_1 \text{ op } b_2$
- The general form of a unary logic operation: $\text{op } b_1$
 - b_1 and b_2 are expressions or variables
 - op is one of the following

Operator	Operation
&	Logical AND
&&	Logical AND with shortcut evaluation
	Logical OR
	Logical OR with shortcut evaluation
xor	Logical exclusive OR
~	Logical NOT

$\Rightarrow 1 \& 1 \quad \Rightarrow 1 \sim 0 \quad \Rightarrow \text{or}(1, 0)$
logical 1
 $\Rightarrow 1 \quad \Rightarrow \sim 1 \quad \Rightarrow 1 \quad \Rightarrow \text{ans} = 1$
logical 0
 $\Rightarrow \text{ans} = 1$
logical 0

- who: List current variables
- whos: List current variables in details
- clear x: Clear variable x from memory
- clear all: Clear all variables from memory
- open: opens new file
- figure(n): opens new figure numbered n
- close: closes last figure
- close all: closes all figures
- dir: List files in directory
- format: Set output format
- Help: to know about any command and example
- Lookfor: to search for command
- exit: quits MATLAB

يُعقل لِمَا يَعْلَمُ بِهِ الْمَوْلَى

لِعَمَانِي أَعْلَمُ بِمَا يَعْلَمُ بِهِ الْمَوْلَى

Help and

لو عَمِلْتَ وَسَلَكْتَ أَوْتُونَتْ
الْبَعْدَ أَكْلَ

$\text{Ctrl} + \text{C}$

Topics

Your answer must clear, every part is doing individual with snap shot as a picture

$$1. x^2 + 2x + 5 = 0$$

a=1 b=2 c=5

Solve this equation by Math Operations

$$x = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

the output will complex number.

* Use command {who, whos} to show variable

If not get (x) from previous.

continue with the result x=-1+2i

- Real(x)
- Imag(x)
- conj(x)
- abs(x)
- angle(x) with radian and degree

from (1) use the same variable not clear them from workspace (a,b,c)

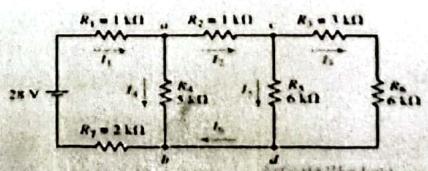
- a>b
- a~=c
- c>=a
- a==1
- 'c'>'b'

Clear command window and workspace

- And(1,1) , 1&1 , 1&0 , And[4,5] , And[[1 1 0],[1 0 1]] , Nand(1,0)
- Or(1,1) , 1|1 , 1|0 , or(2,3) , or[[1 1 0 1 1],[1 0 1 1 0]] , Nor(1,0)
- Xor(1,1) , Xnor(1,0) , xor[[1 1 1],[1 0 1]]

Bonus questions get overall total resistance for this circuit:

application applied for arithmetic operation



\Rightarrow ينقول في الفترة من $(0, 2\pi)$ عاشر
أتمها وأبنته 100 انته بعده

* notes

$$\pi \xrightarrow{\text{6 digits}} \text{Pi}$$

عند انتهاء يذهب الى تقييد

linespace

$$\gg \text{linespace}(0, (2 * \text{Pi}), 100)$$

الاباء ↓
النتائج ↓
عدد النتائج -1

Colon (:) اد هامة اد -5

$$\gg a = (0 : (2 * \text{Pi}) / 99) : (2 * \text{Pi})$$

الاباء ↓
النتائج ↓
عدد النتائج -1

EX/

$$a = (0: 2: 10)$$

ما هو المقص
حيث يكون فيه الارتفاع 2

a =

$$\sim 0 \ 2 \ 4 \ 6 \ 8 \ 10$$

% Vector Arithmetic operations $\xrightarrow{\text{PC-3}}$

* notes

vector \rightarrow one column or one row

$$\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \quad [1 \ 2 \ 3]$$

matrix \rightarrow multiple rows or columns

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

$\gg \text{linspace}(\text{Pi}, -\text{Pi}, 7)$

$$\text{Ans} = \begin{bmatrix} 3.14 & 2.09 & 1.04 & 0 & -1.04 & -2.09 & -3.14 \end{bmatrix}$$

$\gg \text{logspace}(\text{start}, \text{end}, \text{num divisions})$

$$(1), (2), 5$$

Ans =

$$\begin{bmatrix} 10 & 17.7 & 31.62 & 56.12 & 100 \\ 10^{1.25} & 10^{1.5} & 10^{1.75} & 10^2 & 10^2 \end{bmatrix}$$

$\gg \text{logspace}(x, y, n)$

start 10

end 10

in between ✓

للو عاوز اعمل او Format long يسخن كتر من
اربع احاسيم بعد الفصلة منه غير ما اروح
16 digits preference

$\gg \text{format long}$

$\gg 3/4 \rightarrow$ Specified

ans =

$$0.7500000000000000$$

$\gg \text{Format short} \rightarrow$ default \rightarrow
 $\gg 3/4 \rightarrow$ 4-digits after decimal mark

$$\text{ans} = 0.7500$$

\rightarrow preference بعد انجذاب

preference \rightarrow command window

Numeric format \rightarrow (short/long)

\rightarrow preference \rightarrow short انجذاب

$\gg \text{Format longe}$

$$\gg 3/4$$

ans

$$7.500000000000000e-01$$

$\gg \text{Format shorte}$

$$\gg 3/4$$

ans

$$7.5000e-01$$

% Trigonometric Functions sin, cos, tan

$$\gg x = 30;$$

$$\gg y = \sin(x)$$

y =

$$-0.9880 \rightarrow \text{radian}$$

To get it in degrees

$$\gg y = \sin(x + \text{Pi}/180)$$

$$y = 0.5000$$

or

$$\gg y = \sin(\text{d})$$

$$y = 0.5000$$

If we have the value and we need
The angle $\rightarrow \sin^{-1}$

$$\gg \sin^{-1}(0.5)$$

$$\text{ans} = 30.0000$$

% Complex number

How To write complex number

$$\boxed{1} \gg x = 3 + 5i$$

$$\boxed{2} \gg \text{complex}(3, 5)$$

How To get real, imaginary

$$\gg \text{real}(x) \quad \text{ans} = 3$$

$$\gg \text{imag}(x) \quad \text{ans} = 5$$

To get diff between abs, imag value

$$\gg y = \text{abs}(x)$$

$$y = 5.8310$$

To know angle $s_3 = v$, $\tan v = r$

$$\gg \text{angle}(x) = -0.5404 \quad \text{atan} = \frac{5}{3}$$

$$\gg i \quad \gg i^2 \quad \gg i^3$$

$$0+ii \quad -1 \quad 0-ii$$

% Fractional

$$\gg \text{Fractional}(5)$$

للو عاوز اجيب مجموع عدد

$$\text{ans} = 120$$

5- $\Rightarrow \text{flip} = \text{True}$ because
 $\gg x = [1 2 3; 4 5 6]$
 $\gg \text{Flip}(x)$

3 2 1 6 5 4
 $\gg \text{Flipud}(x)$
4 5 6
1 2 3

3- $\Rightarrow a = [1 2 3 4 5 6]$

1 2 3 4 5 6
 $\gg a(2)$
comes to first 2 numbers - X system
3
 $\gg a(2:4) [3 4 6]$

3 4 6
 $\gg a(2: \text{end}-1)$
3 4 6

4- $\gg x = [1 2; 4 2 3]$

$\gg \text{max}(x)$

(4, 2)
 $\gg \text{max}(\text{max}(x))$
4

1- $\Rightarrow \cos(\pi)$

-1

$\gg \cos(18)$
-0.985

لها يتعامل مع المدخلات أكتب

$\gg \cos(180)$

-1

2- $\gg \text{conj}(x)$

3.0000 -4.0000 i

لها ي التعامل مع المدخلات E1
 $x = 3 + 4i$

$\Rightarrow \text{conj}(3 + 4i) = 3 - 4i$

<p>% Max, Min, sum, length, mean for vector or matrix</p> <p>$\gg [2, 3, 4, 5, 6, 9] = X$</p> <p>$\gg \text{length}(X) = 6$ يشوه منه أكثر من المعنونة الصوت والصور ونافذة تفتح كل مرة يهون، ثم علوان inv (011) يتن لومصفوفة 3+4 يعني الـ length يساوى 4</p> <p>$\gg \text{mean}(X) = 4.8333$ يجدهم مفروم على عددهم</p> <p>$\gg \text{max}(X) = 9$ أكبر رقم في المصفوفة</p> <p>$\gg \text{min}(X) = 2$ أقل رقم في المصفوفة</p> <p>% Reshape (X, nRows, nColumns)</p> <p>ex $\gg \text{reshape}(X, 6, 1)$ $\text{ans} = \begin{bmatrix} 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 9 \end{bmatrix}$ 6x1</p> <p>$\gg \text{reshape}(X, 2, 3)$ $\gg \text{reshape}(X, 3, 2)$ $\text{ans} = \begin{bmatrix} 2 & 4 & 6 \\ 3 & 5 & 9 \end{bmatrix}$ 2x3 $\text{ans} = \begin{bmatrix} 2 & 5 \\ 4 & 9 \end{bmatrix}$ 3x2</p>	<p>% Random</p> <p>To generate random values between 0 and 1</p> <p>$\gg \text{rand}(1)$ ans = 0.1628</p> <p>$\gg \text{rand}(1)$ ans = 0.1190</p> <p>$\gg \text{rand}(1, 6)$ $\gg \text{rand}(2 \times 4)$ ans = vvvv $\text{ans} = \begin{bmatrix} v & v & v & v \\ v & v & v & v \end{bmatrix}$ vector هذا عاوز اجيب متناه ارتبطة منه هيرتفع متناه ارتبطة منه هيرتفع</p> <p>$\gg y = \text{sort}(\text{ans}, \text{'ascend'})$ $\gg y = \text{sort}(\text{ans}, \text{'descend'})$</p>	<p>لوعاوز عاوزة مكفرنة مع inverse لـ العاوز</p> <p>$\gg X = [123; 456; 789];$</p> <p>$\gg Y = \text{inv}(X)$ تأكيد من الماخ $\text{ans} = \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix}$ عالم</p> <p>لوعاوز اجيب مصفوفة مجموع الـ 0 → +6 صارى مجموع اي صور</p> <p>$\gg \text{Magic}(3)$ $\gg 3 + 3$ $\text{ans} = \begin{bmatrix} 8 & 1 & 6 \\ 3 & 5 & 7 \\ 4 & 9 & 2 \end{bmatrix}$ 15 $\gg \text{magic}(4)$ 15</p> <p>$\text{ans} = \begin{bmatrix} 16 & 2 & 3 & 13 \\ 5 & 11 & 10 & 8 \\ 9 & 7 & 6 & 12 \\ 4 & 14 & 15 & 1 \end{bmatrix}$</p>	<p>لوعاوز استبدل مثب حفظ الماوز</p> <p>$\gg X(3, 2) = [0]$ $\gg X(3, 2) = [0]$</p> <p>$X = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 0 & 9 \end{bmatrix}$</p> <p>لوعاوز استبدل صفر او صور كامل</p> <p>$\gg X(3, :) = []$</p> <p>$X = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$</p> <p>% To get The Transpose of matrix</p> <p>$\gg Y = X'$</p> <p>$Y = \begin{bmatrix} 6 & 3 & 7 \\ 2 & 5 & 8 \\ 3 & 8 & 9 \end{bmatrix}$</p> <p>% To determine matrix</p> <p>$\gg Z = \det(X)$</p> <p>$Z = \text{value}$</p> <p>% To repeat a certain value inside matrix</p> <p>$\gg Z = \text{ repmat}(5, 3, 2)$</p> <p>element row columns to be repeated</p> <p>$Z = \begin{bmatrix} 5 & 5 \\ 5 & 5 \\ 5 & 5 \end{bmatrix}$</p> <p>طبع لوعاوز اكبر string</p> <p>$\gg Z = \text{repmat}('A', 2, 2)$</p> <p>$Z = \begin{bmatrix} A & A \\ A & A \end{bmatrix}$</p> <p>لوعاوز استبدل فتح صور او صحفه</p> <p>$\gg X(3, :) = [4 4 4]$</p> <p>$X = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 4 & 4 & 4 \end{bmatrix}$</p> <p>لوعاوز استبدل فتح صور حفظ الماوز</p> <p>$\gg X(3, 1) = [4 4 4]$</p> <p>$X = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 4 & 4 & 4 \end{bmatrix}$</p> <p>لوعاوز استبدل فتح صور قبل وبعد الكلمات صلزر في بعضه</p>
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Entering Numeric matrices

```


$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$
 → » a=[1 2;3 4] ← Use square brackets []
a =
 1   2
 3   4

```

Row separator
semicolon (;)

Column separator
space / comma (,)

```

» b=[-2.8, sqrt(-7), (3+5+6)*3/4]
b =
 -2.8000  0 + 2.6458i  10.5000
» b(2,5) = 23
b =
 -2.8000  0 + 2.6458i  10.5000  0   0
          0   0   0   0  23.0000

```

- Any MATLAB expression can be entered as a matrix element
- Matrices must be rectangular. (Set undefined elements to zero)

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Entering Numeric matrices

Addition

Creating sequences:
colon operator (:)

```

» w=[1 2;3 4] + 5
w =
 6   7
 8   9
» x = 1:5
x =
 1   2   3   4   5
» y = 2:-0.5:0
y =
 2.0000  1.5000  1.0000  0.5000  0
» z = rand(2,4)
z =
 0.9501  0.6068  0.8913  0.4565
 0.2311  0.4860  0.7621  0.0185

```

Utility functions for creating matrices.

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E-notation

```

» a = [5E-1 7E-2 9e-4]
a =
 0.5000  0.0700  0.0009

```

$$\begin{aligned} E-1 &= 0.1 \\ E-2 &= 0.01 \\ E-4 &= 0.0001 \end{aligned}$$

Invers

```

» x = [1 2; 1 6];
» y = INV(X);

```

1.5	-0.5
-0.25	.25

```

» X * y   » y * X

```

1.0	1.0
0.1	0.1

Lucky inverse if it will give
out all zeros in a

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Transpose

```

>> a = [1 2; 3 4]
a =
1   2
3   4
    Two cases
    Rotat'e
    or
    TRAnsPole
    >> rot90(a)
    ans =
1   3
2   4
    2   4
    1   3
    1   3
    2   4
  
```

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Complex Numbers (trans)

- Note:
- Transpose(x) $\equiv x'$.
- x' is a non conjugate transpose of x where it only replaces the rows by the columns.
- x' is a conjugate transpose of x where it replaces the rows by the columns and get the conjugate of imaginary numbers.
- When dealing with only real numbers, x' is the same as x .

- Example:
Define any 2 square matrix A and B. Check that $A/B \equiv A \cdot \text{inv}(B)$ and $A\backslash B \equiv \text{inv}(A) \cdot B$.

MATLAB Operations

Matrix Transpose

Math representation	Matlab interpretation
---------------------	-----------------------

$$C = A^T \quad \gg C = A'$$

- For complex-valued matrices, complex conjugate transpose

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \quad a = [1+j2 \quad 3+j4]$$

$$\gg B = A'; \quad \gg b = a';$$

$$B = \begin{bmatrix} 1 & 4 \\ 2 & 5 \\ 3 & 6 \end{bmatrix} \quad b = \begin{bmatrix} 1-j2 \\ 3-j4 \end{bmatrix}$$

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transposition

```

>> a=[1 2 3; 1 2 3; 1 2 3]      1 2 3
a =                                1 2 3 = a
1 2 3
>> rot90(a)
>> ans =
3   3   3
2   2   2
1   1   1
    180
  
```

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Scalar addition

```

>> a=[1 2; 3 4]
a =
1   2
3   4
>> b=a+2
b =
3   4
5   6
  
```

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Addition

```

>> a=[1 2; 3 4]
a =
1   2
3   4
>> b=[1 -1; 2 -2]
b =
1   -1
2   -2
>> c=a+b
c =
2   1
5   2
  
```

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Scalar multiplication

```

>> a=[1 2; 3 4]
a =
1   2
3   4
>> b=2*a
b =
2   4
6   8
  
```

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Multiplication

```

>> a=[1 2; 3 4]
a =
1   2
3   4
>> b=[1 -1; 2 -2]
b =
1   -1
2   -2
>> c=a*b
c =
5   -5
11  -11
  
```

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Power

```

>> a=[1 2; 3 4]
a =
1   2
3   4
>> b=a^2
b =
7   10
15  22
  
```

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- The matrix must be square.
- a^2 is equivalent to $a * a$

Matrix Multiplication

```

>> a = [1 2 3 4; 5 6 7 8];
    [2x4]
>> b = ones(4,3);
    [4x3]
>> c = a*b;
    [2x4] * [4x3] --> [2x3]
c =
    10   10   10
    26   26   26
    a(2nd row).b(3rd column)
  
```

matrix Multiplication

```

>> a = [1 2 3 4; 5 6 7 8];
>> b = [1:4; 1:4];
>> c = a.*b;
c =
    1   4   9   16
    5   12  21   32
    c(2,4) = a(2,4)*b(2,4)
  
```

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Inverse

```

>> a=[1 2; 3 4]
a =
    1   2
    3   4
>> b=inv(a)
b =
    -2.0000   1.0000
    1.5000  -0.5000
  
```

WITH INVERSE

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Inverse

```

>> a=[1 2; 3 4]
a =
    1   2
    3   4
>> b=a^-1
b =
    -2.0000   1.0000
    1.5000  -0.5000
  
```

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Inverse

```

>> a=[1 2; -1 -2]
a =
    1   2
    -1  -2
>> b= inv(a)
Warning: Matrix is singular to
working precision.
b =
    Inf   Inf
    Inf   Inf
  
```

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Division

- In MATLAB A\B is use to solve the system of equation:

$$Ax = B$$

A\B is equivalent to **A⁻¹B**. However, A\B is significantly faster than A⁻¹B.

$$a/b = inv(b)^+ a$$

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MATLAB Operations

Left(\) and Right(/) Matrix "division"

Math representation

$$C = A^{-1}B$$

>> C=A\B;

Math representation

$$C = BA^{-1}$$

>> C=B/A;

Remember, A must be square and full rank (linearly independent rows/columns)

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Division

```

>> A=[1 1;1 -1]
A =
    1   1
    1  -1
>> B=[2;0]
B =
    2
    0
>> x=A\B
x =
    1
    1
  
```

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Division
Answers to 1st part

Solve:

$$x_1 + x_2 = 2$$

$$x_1 - x_2 = 0$$

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Division

The given the system can be written in form:

$$\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$

To solve this system in MATLAB, we proceed as follows:

Solving equation more example

- Given a system of linear equations
 - $x+2y-3z=5$
 - $-3x-y+z=-8$
 - $x+y+z=0$
 - Construct matrices so the system is described by $Ax=b$
 - $A=[1 \ 2 \ -3; -3 \ -1 \ 1; 1 \ 1 \ -1]$
 - $b=[5; -8; 0]$
 - And solve with a single line of code!
 - $x=A\backslash b$; Or $x=inv(A)\cdot b$
 - x is a 3×1 vector containing the values of x , y , and z
- $x =$
 2.0000
 3.0000
 1.0000
- $\Delta X = b$
 $X = inv(A) \cdot b$
- MATLAB makes linear algebra fun!
- 

Array operations

- Add a point before the arithmetic operation to convert it to an element by element operation (array operation).

Array operations

```
> a=[1 2; 3 4]
a = 1 2
      3 4
> b=[1 -1; 2 -2]
b = 1 -1
      2 -2
> c=a.*b
c = 1 -2
      6 -8
```

يكتبون
جهاز كمبيوتر
لهم الله

Array operations

```
> a=[1 2; 3 4]
a = 1 2
      3 4
> b=[1 -1; 2 -2]
b = 1 -1
      2 -2
> c=a./b
c = 1.0000 -2.0000
      1.5000 -2.0000
```

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Array operations

```
> a=[1 2; 3 4]
a = 1 2
      3 4
> b=[1 -1; 2 -2]
b = 1 -1
      2 -2
> c=a.^b
c = 1.0000 0.5000
      9.0000 0.0625
```

$$a^2 = a * a$$

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Array operations

```
> a=[1 2; 3 4]
a = 1 2
      3 4
> c=1./a
c = 1.0000 0.5000
      0.3333 0.2500
```

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Array operations

```
> a=[1 2; 3 4]
a = 1 2
      3 4
> c=a.^2
c = 1 4
      9 16
```

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Determinant

```
> a=[1 2; -1 -2]
a = 1 2
      -1 -2
> d=det(a)
d = 0
```

$$\begin{vmatrix} 1 & 2 \\ -1 & -2 \end{vmatrix}$$

Summation

- For vectors, $\text{sum}(x)$ is the sum of the elements of X .
- For matrices, $\text{sum}(x)$ is a row vector with the sum over each column.

Summation

```
>> a=[1 3 5]
a = 1     3     5
>> s=sum(a)
s =
9
```

Summation

```
>> a=[1 2; 3 4]
a =
1     2
3     4
>> s=sum(a)
s =
4     6
```

1-rank(A) provides an estimate of the number of linearly independent rows or columns of a matrix A

2- trace(A) sum of the diagonal elements of A.

Example:
>> A=[1 2 5; 0 1 7; 2 3 4];
>> rank(A)

ans =
3
>> trace(A)  Sum of diag[ur]
ans =
6

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Example2:

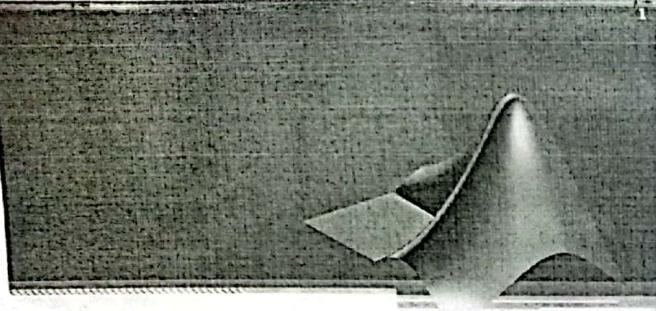
```
>> A=[1 2 5; 2 4 10; 2 3 4];
>> rank(A)
ans =
```

2

Example3:

```
>> A=[2 3; 4 6];
>> rank(A)
ans =
1
>> >> trace(A)
ans =
8
```

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matrix Subscripting

The Matrix in MATLAB

		Columns (n)				
		1	2	3	4	5
Rows (m)	1	4	10 ¹	1 ¹¹	6 ¹⁶	2 ²¹
	2	8 ²	1.2 ⁷	9 ¹²	4 ¹⁷	25 ²²
3	7.2 ³	5 ⁴	7 ¹³	1 ¹⁸	11 ²³	
4	0 ⁵	0.5 ⁶	4 ¹⁴	5 ¹⁹	56 ²⁴	
5	23 ⁷	83 ⁸	13 ¹⁵	0 ¹⁶	10 ²⁵	

Rectangular Matrix:
Scalar: 1-by-1 matrix
Vector: m-by-1 matrix
1-by-n matrix
Matrix: m-by-n matrix

matrix Subscripting / Indexing

$A = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 4 & 10^1 & 1^{11} & 6^{16} & 2^{21} \\ 8^2 & 1.2^7 & 9^{12} & 4^{17} & 25^{22} \\ 7.2^3 & 5^4 & 7^{13} & 1^{18} & 11^{23} \\ 0^5 & 0.5^6 & 4^{14} & 5^{19} & 56^{24} \\ 23^7 & 83^8 & 13^{15} & 0^{16} & 10^{25} \end{bmatrix}$						
$A(1,5)$	$A(:,5)$	$A(3,1)$	$A(4,5,2,3)$			

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Chosen row or column

```
>> a=pascal(3)
ans =
    1    1    1
    1    2    3
    1    3    6
>> a(:,1)
a =
    1
    1
    1
```

دالة $\text{a}(:,1)$ ترجع
الكل عمود 1

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Chosen row or column

```
>> a=pascal(3)
ans =
    1    1    1
    1    2    3
    1    3    6
>> a(1,:)
a =
    1    1    1
```

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Chosen row or column

```
>> a=pascal(3)
ans =
    1    1    1
    1    2    3
    1    3    6
>> a(:,1)
a =
    1
    1
    1
```

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Chosen row or column

```
>> a=pascal(3)
ans =
    1    1    1
    1    2    3
    1    3    6
>> a(:,[1 2])
a =
    1    1
    1    2
    1    3
```

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Chosen row or column

```
>> a=pascal(3)
ans =
    1    1    1
    1    2    3
    1    3    6
>> a([1 2],[1 2])
a =
    1    1
    1    2
```

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Deleting Rows and Columns

```
>> A=[1 5 9;4 3 2;5; 0.1 10 3i+1]
A =
    1.0000      5.0000      9.0000
    4.0000      3.0000      2.5000
    0.1000     10.0000  1.0000+3.0000i
>> A(:,2)={}
A =
    1.0000      9.0000
    4.0000      2.5000
    0.1000     1.0000 + 3.0000i
>> A(2,2)={}
??? Indexed empty matrix assignment is not allowed.
```

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Chosen row or column

```
>> a=pascal(3)
a =
 1   1   1
 1   2   3
 1   3   6

>> b=a([1 end],[1 end])
b =

 1   1
 1   6
```

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Numerical matrix Concatenation

Use [] to combine existing matrices as matrix "elements"

Row separator:

Column separator:

```
>> a=[1 2;3 4] ← Use square brackets []
a =
 1   2
 3   4
>> cat_a=[a, 2*a; 3*a, 4*a; 5*a, 6*a]
cat_a =
 1   2   2   4
 3   4   6   8
 3   6   8   8
 9   12  12  16
 5   10  6   12
 15  20  18  24
```

Note:
The resulting matrix must be rectangular

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Concatenation

```
>> x=[2,3]
a =
 2   3
>> x=[x,5]
x =
 2   3   5
>> x=[x,-1,-3]
x =
 2   3   5   -1   -3
```

↓↓↓↓↓ ↓↓↓↓↓
↓↓↓↓↓ ↓↓↓↓↓

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Concatenation

```
>> a=[1 2]
a =
 1   2
>> b=[3 4]
b =
 3   4
```

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Concatenation

```
>> c=[a b]
c =
 1   2   3   4
>> d=[a;b]
d =
 1   2
 3   4
```

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Vector and Matrix Operations

- +, -, *, ./ are used in operations between matrices
- .*, ./, ^ are used in operations between matrix elements
- Pay attention to the dimensions of vectors and matrices

Exercise

- ❖ 10 mints
 - ❖ $x=[1 \ 2 \ 3 \ 4]; y=[5 \ 6 \ 7 \ 8];$
 - ❖ $z1=[1 \ 2 \ 3]; z2=[4 \ 5 \ 6];$
 - 1) Sum of x and y
 - 2) Product of x and y
 - 3) Bitwise product of x and y
 - 4) Bitwise division of z1 over z2
 - 5) Bitwise division of z1 over z2, but for the first two elements only (both the expression and result)
- Answer: 1) [6 8;10 12]; 2) [19 22;43 50];
 3) [5 12;21 32];4)(0.25 0.4 0.5);
 5) $z1(1:2)/z2(1:2)=[0.25 \ 0.4]$

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Matrix Manipulation Functions

Function	Syntax	Description	Example
Determinant	$B=det(A)$	B (a number) is the determinant of A (a square matrix)	$C=2^*det(A)$
Inverse	$D=inv(A)$	D (a square matrix) is the inverse of A (a square matrix)	$A=inv(B*C)$
Rank	$N=rank(A)$	N (a number) is the rank of A (a matrix)	$h=rank(A)-1$
Diagonal	$A=diag(C)$	A is the main diagonal elements of C	$A=2+diag(B)$
Sum	$A=sum(B)$	A is the sum of all elements of B if it is a vector or sum of columns of B if it is a matrix	$A=sum(x)$
Transpose	$A=transpose(b)$	A is the none conjugate transpose of b Or $A=b'$	$A=transpose(b)$ Or $A=b'$

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↙ ↘
 $\Rightarrow x=[1 \ 3 \ 4 \ 5]$

$\Rightarrow Y = [X \ ; \ 2^X \ ; \ 3^X]$
 $1 \ 3 \ 4 \ 5 \ 1$
 $\Rightarrow Y = [X \ ; \ 2^X \ ; \ 3^X]$

$1 \ 3 \ 4 \ 5$
 $2 \ 6 \ 8 \ 10$
 $3 \ 9 \ 12 \ 15$

$\Rightarrow Z = [X \ ; \ 2^X \ ; \ 3^X]$
 $\Rightarrow Y = [X \ ; \ 2^X \ ; \ 3^X \ ; \ Z]$
 $1 \ 3 \ 4 \ 5$
 $2 \ 6 \ 8 \ 10$
 $3 \ 9 \ 12 \ 15$
 $2 \ 3 \ 4 \ 5$

لوب لعاظر ارسن المصنوعة كلها في كام

```
>> Z = 2e(x)
ans
3 4
عدد الصور
>> [Y, C] = size(X)
ans
Y = 3
C = 4
 عدد الصور
```

% PLOTS

لوب لعاظر اعمل اعمل

- 1- Home \rightarrow new script
- 2- Select comment
- 3- % 2D plots

```
>> X = linspace(0, 2*pi, 100);
>> Y = sin(X);
>> plot(Y)
```

لوب لعاظر اغير اعداد المعاوრ والصيغ

```
>> xlabel('time');
>> ylabel('angle');
>> title('sin wave curve');
>> legend('sin')
يسعني لويندوز جه
ده بفتح المعاو
Run سنه موق
يد كده هتختار كلها
واعمل savefile
```

notes

يمكنك تعديل وعمل Editor للتكبير والتصغير
واكمل المعاو والستوك وكل شئ عن
الاكبر

لوب لعاظر ارسن اكتر منه كيدف

```
>> Y = sin(X);
>> Z = cos(X);
>> plot(X, Y, X, Z)
space
```

وأضيف

وأعمل باردي

Run اعمل

مرسمنه ونمط الموج فتح ضيكتون واحد

لوب لعاظر اعمل

Y = sin(X);

Z = X;

plot(X, Y, Z)

لوب لعاظر اخط اكتره جبو صيغ

وأعمل اطار

on/off

on/off

% 3D plot(surface)

[X, Y] = meshgrid(0:2*pi/100:2*pi, 0:15)

Z = sin(X) + cos(Y)

surf(X, Y, Z)

اندر Run هيطلع كل اكتره سروم

% subplot

لوب لعاظر اعمل

X = linspace(0, 2*pi, 100);

Y = sin(X);

Z = cos(X);

subplot(2, 1, 1);

لوب لعاظر اكتر

لوب لعاظر اكتر

plot(X, Y);

subplot(2, 1, 2);

plot(X, Z);

ادو Run

لوب لعاظر ارسن غير منه 2 في اربع

مختلفة ولديك هنا واحد فوق الثاني

لوب لعاظر ارسن مهم بعضا

صغير به subplot

subplot(1, 2, 1);

subplot(1, 2, 2);

وهكذا

لوب لعاظر اعمل 3 في 4 كيرف

10/2 5

10/5 0.5

% polynomial

$2x + y + 3z = 9$

$3x + 2y + z = 6$

$x + 3y + 2z = 8$

لوب لعاظر اعمل

A = [2 1 3; 3 2 1; 9 3 2];

B = [9; 6; 8];

X = A \ B

backslash divide

X = 0.611

0.944

2.278

X = inv(A) * B

for loop time

$5^4 + 35^3 - 15^2 - 25 + 9$

X = [1 3 -15 -2 9];

roots(X)

ans

-5 --

-2 --

-0.7 --

-4.78 --

لوب لعاظر الـ Roots

d = [-5; -2; -0.7; -4.78];

poly(d)

ans

Columns 1

1 --> 3

Columns 4

-2.0002 9.007

Polynomial

$5^4 + 35^3 - 15^2 - 25 + 9$

ans

-5 --

-2 --

-0.7 --

-4.78 --

لوب لعاظر الـ Roots

d = [-5; -2; -0.7; -4.78];

poly(d)

ans

Columns 1

1 --> 3

Columns 4

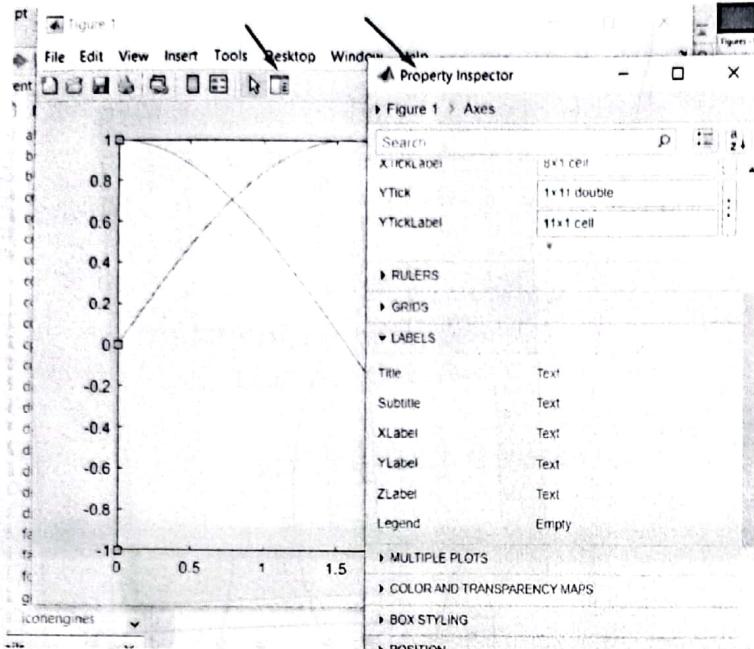
-2.0002 9.007

grid on
title

دعا

أعلى اليمين
plot

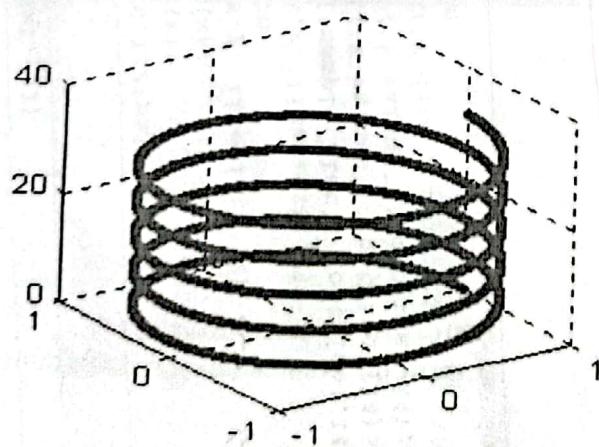
Kin o دعا



SPRING دعا

- Example: Plot the helix
- $x = \cos t, y = \sin t, z = t, 0 < t < 10\pi$

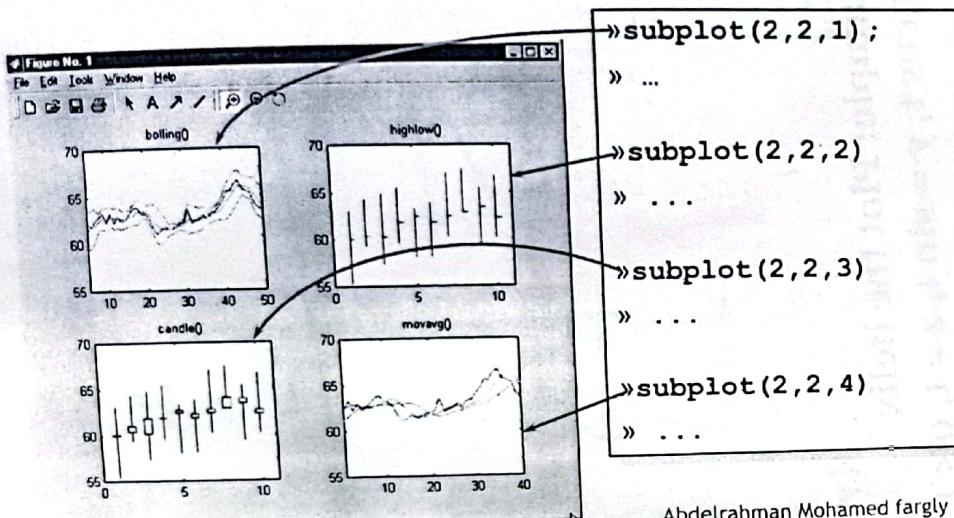
```
t=0:0.01:10*pi;
x=cos(t);
y=sin(t);
z=t;
plot3(x,y,z,'r.')
grid on
```



Subplots

Syntax:

```
subplot(rows,cols,index)
```



2-D Plotting example (tot)

Syntax:

```
plot(x1, y1)
```

Example:

```
x=[0:0.1:2*pi];  
y=sin(x);  
z=cos(x);  
plot(x,y,'linewidth',2) → خط اكبر  
hold on  
plot(x,z,'linewidth',2)  
title('Sample Plot','fontsize',14);  
xlabel('X values','fontsize',14);  
ylabel('Y values','fontsize',14); } both label  
legend('Y data','Z data')  
grid on
```

خط اكبر
both label
legends

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mesh function

mesh function

- The MATLAB function `mesh` is used to plot surfaces.

- The MATLAB function `mesh` is used to plot surfaces.
- Surfaces are usually represented by a function of two variables:
- $z = f(x, y)$

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mesh function

- The MATLAB function `mesh` is used to plot surfaces.
- Surfaces are usually represented by a function of two variables:
- $z = f(x, y)$
- To use this function we have to use `meshgrid` first to generate pairs (x, y)

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meshgrid by example

```
>> x=0:2
x = 0    1    2
>> y=0:2
y = 0    1    2
>> [X,Y]=meshgrid(x,y)
```

meshgrid by example

```
>> x=0:2
x = 0    1    2    1x3
>> y=0:2
y = 0    1    2    1x3
>> [X,Y]=meshgrid(x,y)
X = 0    1    2
    0    1    2
    0    1    2
Y = 0    0    0
    1    1    1
    2    2    2
```

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mesh Example 1

- Example: Plot the surface
- $z = x^2 + y^2$

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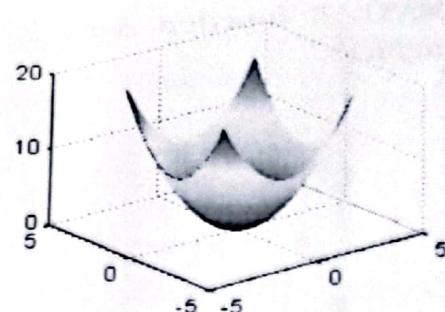
mesh Example 1

- Example: Plot the surface

- $z = x^2 + y^2$

```
x=-3:0.01:3;
y=-3:0.01:3;
[X,Y]=meshgrid(x,y);
z=X.^2+Y.^2;
mesh(X,Y,z)
```

mesh Example 1



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mesh Example 2

- Example: Plot the surface
- $7x - y + z = 3$

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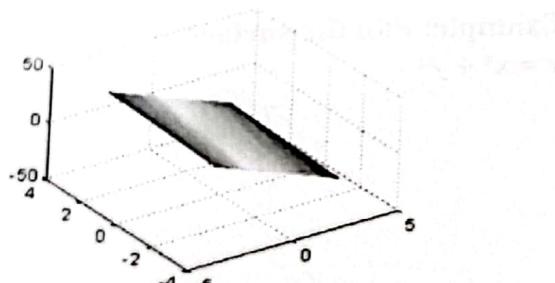
mesh Example 2

- Example: Plot the surface
- $7x - y + z = 3$

```
>> x=-3:0.1:3;
>> y=-3:0.1:3;
>> [X,Y]=meshgrid(x,y);
>> z=3-7*x+y;
>> mesh(X,Y,z)
```

مكتبة ملائكة
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mesh Example 2



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Other Useful Graphics Commands

You may find the following set of commands useful:

Function	Used to
plot3	Create a graph for a 3D data representing a space curve
loglog	Create a graph with logarithmic scales for both axes
semilogx	Create a graph with logarithmic scale for the x axis only
semilogy	Create a graph with logarithmic scale for the y axis only
plotyy	Create a graph with y-tick labels on the left and right side
gtext	Position text using the mouse
clf	Clears the figure
ginput	Gather data by clicking on points in the plot

M files and Programming

Editing and Debugging M-Files

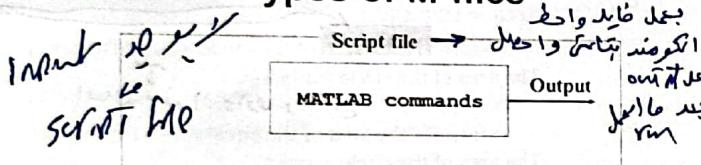
- What is an M-File?
- The Editor/Debugger
- Debugging M-Files
 - Types of Errors (*Syntax Error* and *Runtime Error*)
 - Using *keyboard* and “;” statement
 - Setting Breakpoints

M-file
• A MATLAB program is a sequence of MATLAB commands stored in an external file called an m-file.

- The program is executed by writing the file name in the MATLAB command window and pressing Enter or press run.

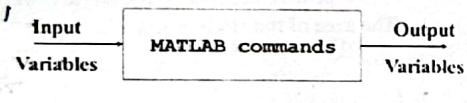
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Types of M-files



Ge fatto dal fatto da

جاء من قبل



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Script File

- **Script File**
- Script file is usually used to collect a sequence of MATLAB commands and execute them together.
 - For example, plotting a function using *plot* command needs a sequence of commands. These commands are written in a single file and executed together by writing the file name in the command window.

Script File Construction

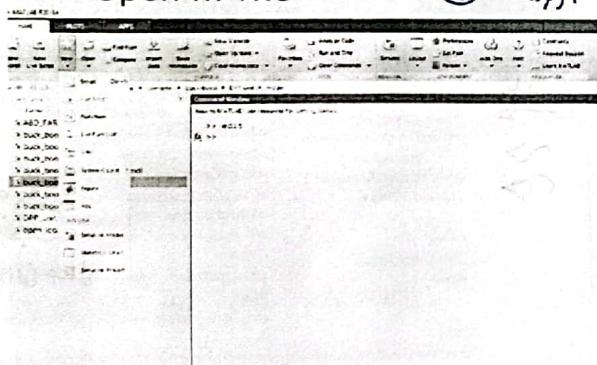
Steps

- To write a script file, choose *File->New->M-File* from the MATLAB menu which opens the MATLAB editor.
- Write the script and save it.
- Press run

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Open m-file

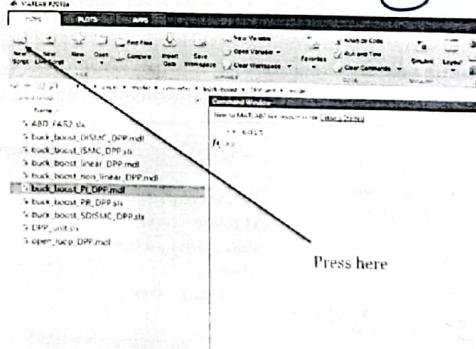
① تحرير



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.m-file Interface

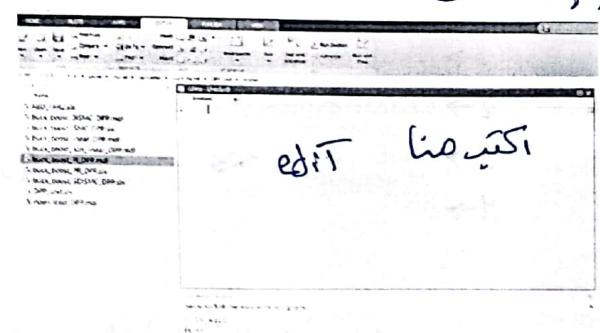
② تحرير



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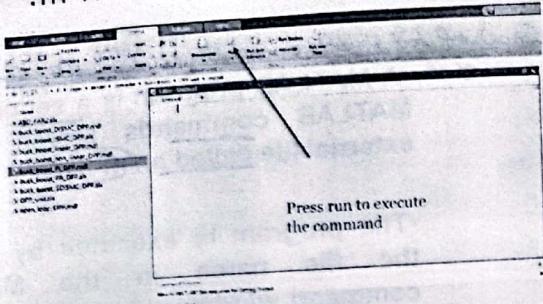
.m-file Interface

③ تحرير



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.m-file Interface



Programming

وهي لغة البرمجة
وهي لغة ادخال و вывод
وهي لغة ادخال و вывод
والبيانات

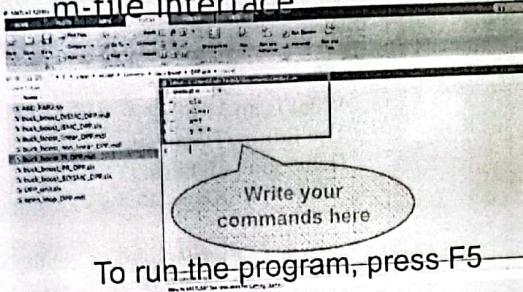
Basic Control Statements-if

- if, elseif, end
- 1 → IF expression statements
- 2 → ELSEIF expression statements
- 3 → ELSE statements
- 4 → END

فيما يلي مثال

إذا كان العدد أكبر من 100
فأدخله في المدخل
إلا إذا كان العدد أقل من 100
فأدخله في المدخل

m-file Interface



جاءكم بكتاب الملف المكتوب
فتح الملف وادخلوا انت هنا
لديكم معاور

Reading input from keyboard

X=input('type length :')

Type length : |

Type length : 4

X =

4

X=input('type name: ','s')

Type length : |

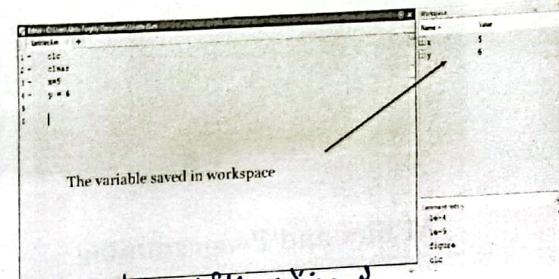
Type length : ahmed

X =

ahmed

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لديكم معاور

.m-file Interface



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Output format

area = 123.452 ;

• >> fprintf ('the area of the circle =%12.3f\n',area)

The area of the circle = 123.452

• >> fprintf ('the area of the circle =%12.1 f\n',area)

The area of the circle = 123.5

• >> fprintf ('the area of the circle =%12.0 f\n',area)

The area of the circle = 123

⇒ area = 75;
⇒ disp('area');
area

Basic Control Statements-if

if statement

if statement used to execute code once when the logical test (expression) returns a true value (1). An "else" statement following an if statement is executed if the same expression is false (0).

Syntax:

```
if expression
    Statements1;
else
    Statements2;
end
```

Discount in Sales application

```
price=input('Enter the price');
if price>1000
    discount=.30/100
else
    discount=.5/100
end
price=price-price*discount
```

Syntax:

```
if expression1
    Statements1;
else
    expression2
    Statements2;
else
    expression3
    statements3;
end
```

Note:

To write multiple conditions in the expression we use logical operators
as: $0 < x \leq 1$

Discount in Sales application:

```
price=input('Enter the total price');
if price>1000
    discount=.30/100
else
    discount=.25/100
else
    discount=.20/100
else
    discount=.10/100
else
    discount=.05/100
end
price = price - price*discount
```

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لديكم معاور

Statements-if example 1

```

Editor - C:\Users\abdo\Documents\MATLAB\Untitled6.m
File Edit Text Go Cell Tools Debug Desktop Window Help
1 - x=input('enter number = ');
2 - if rem(x,2)==1
3 -     disp('odd')
4 - elseif rem(x,2)~1
5 -     disp('even')
6 - else
7 -     disp('error')
8 - end

```

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Statements-if example 1

```

Command Window
1 New to MATLAB? Watch this Video, see Demos or read Getting Started
enter number = 10
even
enter number = 9
odd
fx >> |

```

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Basic Control Statements-for

- for, end
 - for variable=expression
statement;
 - end
- expression: initial value: increment: end value
- \Rightarrow For i=1:10
 $x(:)=input('Enter The number =');$
 end

لـ for سـ لـ
 بـ دـ لـ وـ لـ
 وـ لـ

لـ جـ لـ دـ لـ سـ لـ
 لـ سـ لـ دـ لـ وـ لـ
 (x)

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Statements-for example

```

1 - x=zeros(2,2);
2 - for i=1:2
3 -     for j=1:2
4 -         x(i,j)=input('enter number = ');
5 -     end
6 - end

```

$i=1:2$ $j=1:2$

لـ جـ لـ دـ لـ سـ لـ
 لـ سـ لـ دـ لـ وـ لـ

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For can also used in array not only in programming :

• Example.

```

for i = 1:6
X(i)=(i-1)*0.1;
End

>>x
X= 0 0.1 0.2 0.3 0.4 0.5

```

Double and triple loops can be written as :

example:

```

for r=1:3
for s = 1:r
Area = pi * (r^2-s^2);
disp([r,Area])
End
End

```

The solution

Ans:

1	0
2	9.4248
0	2
25.1327	3
3	15.7080
3	0

Statements-for example

```

Command Window
1 New to MATLAB? Watch this Video, see Demos or read Getting Started
inter number = 1
inter number = 2
inter number = 3
inter number = 4
>> x
x =
1 2
3 4
fx >> |

```

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Statements-for example

```

1 - x=input('enter number = ');
2 - for i=1:x
3 -     if rem(i,2)==1
4 -         disp('odd')
5 -     elseif rem(i,2)~1
6 -         disp('even')
7 -     end
8 - end

```

Statements-for example

```
enter number = 10  
odd  
even  
odd  
even  
odd  
even  
odd  
even  
odd  
even
```

جـ ٢ هـ ١٤٣٦ مـ ٢٠١٧
بعـد الـ بـلـاـغـةـ وـ بـيـنـ السـفـاـيـةـ
وـ لـلـزـوـمـ دـيـنـ يـاـيـرـسـ
وـ كـنـسـةـ الـ حـالـيـهـ دـيـنـهـ
شـفـرـ بـيـونـهـ تـوقـفـ لـهـ مـاـ أـكـلـ

Basic Control Statements-while

Basic Control switch

> switch-case statement

switch-case statement
switch statement executes one set of statements selected from an arbitrary number of alternatives. Each alternative is called a case.

Syntax1:

switch expression (scalar or string)

case value1

statement:

... .

erwise

end

Andalatthan Mohamed fargi

Basic Control switch

Unit conversion to "centimeter" application.

```

value=input('Enter the value = ')
unit=input('Enter the unit = ')
switch unit
    case ('inch', 'in')
        output = value * 2.54
    case ('feet', 'ft')
        output = value * 2.54 * 12
    case ('meter', 'm')
        output = value / 100
    case ('centimeter', 'cm')
        output = value / 1000
    case ('millimeter', 'mm')
        output = value / 10000
    otherwise
        output=NaN
end

```

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Exercise

- 10 mins
 - Write a for program to compute
 $0.5+1+1.5+2+\dots+50$
 - x=0;
 - for i=0.5:0.5:50
 - x=x+i;
 - end

against the established fans.

Function m-file *Now → Function*

using an m-file , save as (file name) Then write

- In case of one variables

Function variable = file name (argument1,argument2,...)

Function file example 1

- To create a program which compute the area of a circle
 - Save as : circlarea.m
 - Write : function y =circlarea(x)
 $y=\pi*x^2$

Then in the command window >> A= circarea(6.5)
the answer will be >>A=132.7323

Function m-file

- In case of 2 variables
Function [variable1,variable2] =filename(argument1,argument2)

Function file example 2
To compute the area and the perimeter of a circle:

Save as : circle.m
Write : function [y,p] =circle(x)
y=pi*x^2;
p=2*pi*x;

Then in the command window >> [Area perimeter]=
circle(6.5)

Function m-file

- Important note :

BE sure that the last change in the m-file is saved to not lead to error

New + Save

بعد

Save الملف

Function file example 4

```
Editor - C:\Users\abdo\Documents\MATLAB\ab... X
File Edit Text Go Cell Tools Debug Desktop > X
sumabdo.m - 1.0 + ÷ 1.1 × % % %
1 function [ z ] = abdo( y )
2 z=1;
3 for i=1:y
4 z=z+i;
5 end
6 end
```

Tutorial 5

Function file example

```
Command Window
New to MATLAB? Watch this video, see Demos, or read Getting Started. X
>> abdo(5)

ans =
24

>>
```

Function file example 3

```
Editor - C:\Users\abdo\Documents\MATLAB\su... X
File Edit Text Go Cell Tools Debug Desktop > X
sumabdo.m - 1.0 + ÷ 1.1 × % % %
1 function [ z ] = sumabdo( x, y )
2 z=x+y;
3 end
```

Function file example

>> sumabdo(3,4)

ans =

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Lec - Symbolic & solve eq

كل المقادير لها معامل مع رقم
معها مقدار معامل مع رقم
معها مقدار معامل مع رقم

Some contents of Matlab's
Symbolic Toolbox :-

- 1- Enter expressions in symbolic form
- 2- Expand or Simplify expression
- 3- Find symbolic roots, limits
- 4- Diff of integrate
- 5- solve eqs symbolically
- 6- & simultaneous eqs,
even when non-linear
- 7- Variable precision arithmetic

ازاء افهم اد ماتلاب

سے symbols کو بھولے

$\gg \text{syms } x \ y \ a \ b \ c \ f \ g$

دل التفکر میں اجرا جائے

کہ کہا ہے اکمال کے پڑے

وں اکمال کے پڑے

Command Window

$\gg \text{syms } x \ y \ z \ a \ b \ c$

$\gg z = x + y$

$z =$

$x + y$

(ازاء اصل مقدار مقدار درجہ ۱ اور)

کہ کہا ہے اکمال

$\gg \text{solve}(x+1) == 0$

ans =

-1

$\gg \text{solve } x^2 - 1 == 0$

ans =

1

$-(3^{1/2}) * i / 2 - 1/2$

$-(3^{1/2}) * i / 2 - 1/2$

ازاء اصل مقدار
کے درجہ موجودہ

کہ کہ اکمال کا اصل
مقدار میں معین و نکد
کہ کہنے بلکہ اسی

Solve

$$\begin{cases} x_1 - x_2 = 6 \\ x_1 + x_2 = 2 \end{cases}$$

$\gg \text{syms } x_1 \ x_2$

$\gg [x_1 \ x_2] = \text{solve}(x_1 - x_2 - 6, x_1 + x_2 - 2)$

$x_1 = 2$

$x_2 = -4$

Differentiation

لو عاوز انتقى مقدار سے وڌئي
واعو ز تھا او اخلي

$\gg \text{syms } a \ b \ c \ x \ y \ z$

$\gg f = x + 1$

$\gg \text{answer} = \text{diff}(f)$

answer =

1

کہ انتقى مقدار
مقلوبہ بے کہا اک
کہ کہنے میں مختصر و اکھا
کہ کہنے بالنسیہ ل(x)

$\gg \text{answer} = \text{diff}(f, 2)$

Answer =

0

و عاوز اکھا مرتبہ مثلا

$\gg \text{syms } a \ b \ c \ x \ y \ z$

$\gg f = x^2 + y^2$

$\gg \text{answer} = \text{diff}(f,$

ans

$x^2 * x$

default

کہ کہ دا

y) وونتے بالنسیہ ل

$\gg \text{answer} = \text{diff}(f, 2, 2)$

answer =

2

$\gg \text{syms } a \ b \ c \ x \ y \ z$

$\gg f = a^2 x^2 + b^2 y^2 + c^2 z^2$

$\gg \text{answer} = \text{diff}(f, y)$

ans = $c + 2 * b^2 * y$

طبع لو عاوز المونہ

$\gg \text{subs}(\text{answer}, (a, b, c, (1, 2, 3))$

ans =

13

طبع لو عاوز انتقى مقدار کیسے
و طبعاً ناجع نیہ منیراے کہیں و صور
کہیں و عاوز اکھل تبیہ مقدار

$\gg \text{syms } a \ b \ c \ x \ y \ z$

$\gg f = \exp(-a^2 x)^2 * x^2 * (3^2 b)^2 * \sin(c^2 x),$

$\gg \text{Answer} = \text{diff}(f);$

$\gg \text{simplify}(\text{answer})$

ans =

$x^2 * (3^2 b - 1)^2 * \exp(-a^2 x)^2 * (3^2 b)^2 * \sin(c^2 x) +$
 $c^2 x^2 * \cos(c^2 x) - a^2 x * \sin(c^2 x)$

درعماز احاطہ اکھل ناجع میں مختصر میں
ans

$\gg g = \text{simplify}(\text{answer})$

ولو عاوز ارجع (g) لاملاً قیل لتریبل

$\gg \text{expand}(g)$

حل اضر

integration

برمجه أول حاشه اعزم اعزم
symbols

» Symbs a b c x y z

» f = x + 1

» answer = int(f)
answer = $\frac{(x^2 + (x+1))}{2}$

» answer = int(f, x, 0, 1)
answer = $\frac{3}{2}$

لهمطفقاً و كان هنا كنا متى هيك مل
عندية $r(x)$ يعنيه بار f

طبع لوح عاشر double integral

» f = $x^2 + y^2$

» answer = int(int(f, x), y)

answer
 $x^2 y^2 (x^2 + y^2) / 3$

طبع لوعاء اخليه حل دور

» g = int(int(f, x, 0, 1), y, 0, 2)

g = $\frac{10}{3}$

Limits

» f = sin(2*x) / x

» limit(f, x, 0)

ans =

2

Partial fraction of diff eq

Partial fraction Go Go اسر

residue → Go Partial
variable Go بطر
النقطة بطر
و كذا لعام بيطلعها
residue(a, b)

و اقول ←
b و a و a و a و a
ويطلعها الـ a و a و a

EK

$$\frac{-4x + 8}{x^2 + 6x + 8}$$

» b = [-4 8];

» a = [1 6 8];

» [r, p, k] = residue(b, a)

r = -12, 8

p = -4, -2

k = [] ~ constant view

locus

$$\frac{-4x + 8}{x^2 + 6x + 8} = \frac{-12}{x+4} + \frac{8}{x+2}$$

طبع لومعا

» r = [-12 8];

» p = [-4 -2];
» k = []

» [b, a] = residue(r, p, k)

ans b = -4 8

a = 1 6 8

Nice Trick To Find
Partial Fraction Decomposition

هو انه الـ a و كلها يساوي رقم
و كذا معابد رسم
كل

» Symbs x

» num = -4*x + 8

» denum = x^2 + 6*x + 8

» diff(int(num/denum))

ans

$$8/(x+2) - 12/(x+4)$$

» f = (-4*x + 8) / (x^2 + 6*x + 8)

» diff(int(f))

ans

$$8/(x+2) - 12/(x+4)$$

Differential equations:

يسعى حلها بواسطه

» solve

طريقه الحكيمية

$$\frac{dy}{dx} = D$$

$$\frac{d^2x}{dt^2} = D2x$$

$$t'' + 2t' - 25t = 10$$

Ex » dsolve('D2y + 2*Dy + 25*y = 10')
ans =

y(t) = 10 + y(0) = 1

» dsolve('y' = 't' - 't', 'y(0) = 0', 'y(1) = 1')
ans =

✓

Subject: Laplace Transformation

Date:

$$P(t) = 5 \cos 2t + 3e^{-ut}$$

Ex/ Derive The Laplace Transform
of The unit step function

$$F(s) = \int_0^\infty (1) e^{-st} dt$$

$$\therefore F(s) = \frac{e^{-st}}{-s} \Big|_0^\infty = \frac{1}{s}$$

$$L[f(t)] = F(s)$$

$$L^{-1}[F(s)] = f(t)$$

Algebra eq

Laplace

Time

Author at T

تحويل دالة

نحوية لدالة

$$\Rightarrow P = t^4$$

?? laplace(f)

f =

$$24/s^5 = ?$$

$$= 24/s^5 \cdot (s+2)^5 / (s+2)^5$$

if laplace(f) = time of value in laplace

?? sym s;

$$f'(t) = 24/s^2 = ?$$

if place(f)

inverse $\leftarrow f =$

$$t^4 = ?$$

$$= t^4 + 2t^3 + 3t^2 + 2t + 1$$

Ex/ ?? sym s t

$$\Rightarrow P(t) = \text{laplace}(s^2 \cos(2t) + 3 \exp(-4t))$$

$$P(t) = 1 - 17 + 9 = ?$$

$$\text{laplace } 3/(s+4) + (5s^2)/((s^2+4))$$

$$(s+4)(s^2+4)$$

$$Ex/ F(s) = \frac{3s+2}{s^2+3s+2}$$

$$\Rightarrow \text{num} = [3 \ 2]$$

$$\Rightarrow \text{den} = [1 \ 3 \ 2]$$

$$\Rightarrow [2 \ 3 \ 1] = \text{residue}(\text{num}, \text{den})$$

$$z = 4$$

$$-4 \quad s+2z$$

$$P = 2$$

$$-1 \quad s+2z$$

$$h = (2s+1) = \text{gain}$$

$$([6]) \cdot 2 + 2 = 14$$

$$F(s) = \frac{-1}{(s+1)} + \frac{4}{(s+2)}$$

$$s+2z$$

z Residue constant

P poles

x direct division

Subject:

$$\text{Ex1} \quad 8(s+3)(s-5)(s-1)(s+1)(s+7)$$

$$\Rightarrow \frac{dy}{dt^2} + 8\frac{dy}{dt} + 15y = 30$$

$$\Rightarrow Z = [-3, 5];$$

$$\Rightarrow P = [1 \ -1 \ -7];$$

$$\Rightarrow k = 8;$$

$$\Rightarrow sys = \text{sys}(Z, P, k)$$

$$sys =$$

$$8(s+3)(s-5)$$

$$\frac{(s-1)(s+1)(s+7)}{[s-5]}$$

$$\text{in Matlab: } sys = \text{tf}(num, den);$$

Ex1

$$\frac{3s+2}{s^2+3s+2}$$

$$\Rightarrow num = [3 \ 2];$$

$$\Rightarrow den = [1 \ 3 \ 2];$$

$$\Rightarrow sys = tf(num, den)$$

$$sys = \frac{3s+2}{s^2+3s+2}$$

$$sys =$$

$$\frac{3s+2}{s^2+3s+2}$$

solution of diff eq using L.T.

$$\frac{d^2y}{dt^2} + 8\frac{dy}{dt} + 15y = 30$$

$$\Rightarrow sys = t \cdot y \cdot s^2$$

$$\Rightarrow f = \text{lreplace('diff(y(t),t,t) + 8*y(t), t) = 30;}, s$$

$$\frac{1}{s^2} + 8 \cdot \frac{1}{s} + 15 \cdot y(t) = 30; \quad s$$

$$(s) \quad \text{at } (T=0) \text{ in initial condition}$$

$$f = (s) \quad T = [1, 0]$$

$$8*s + \text{lreplace}(y(t), t, s) = D(y)(0)$$

$$-8 \cdot y(0) - s^2 \cdot y(0) + s^2 \cdot 2 \cdot y$$

lreplace

$$t, s; \quad \text{lreplace}(y(t), t, s) \text{ in lreplace}$$

$$\text{initial conditions in lreplace}$$

$$\Rightarrow f = \text{subs}(f, \{ \text{lreplace}(y(t), t, s) \}) \quad \{ y(0)$$

$$f =$$

$$15 \cdot y - 8 \cdot y(0) - D(y)(0) + 8 \cdot s^2 \cdot y$$

$$-s^2 \cdot y(0) - s^2 \cdot 2 \cdot y = \frac{30}{s}$$

$$\text{lreplace in lreplace}$$

$$\Rightarrow f = \text{subs}(f, \{ y(0) \})$$

$$(0)$$

$$\text{lreplace in lreplace}$$

$$f =$$

$$y^* \cdot s^2 + 8 \cdot y^* \cdot s + 15 \cdot y^* =$$

$$\frac{30}{s}$$

Subject: _____

Date: _____

$\Rightarrow y = \text{solve}(f, 'y')$

نحوه حل y اول لـ f

$y =$

$$30 / (s^2 + 8s + 15)$$

نحوه حل y لـ f

$\Rightarrow \text{sysms } y - t$

$$\Rightarrow \text{ode} = \text{dsolve}'D_2y + 8*Dy + 15 * y = 30'$$

$\text{ode} =$

$$c_2 * \exp(-3*t) + c_3 * \exp(-5*t) + 2$$

III Case

$\Rightarrow \text{sysms } t \ y \ s \ f$

$$\Rightarrow f = \text{laplace}'\text{diff}(y(t), t, t) + 8 * \text{diff}(y(t), t) + 15 * y(t) = 30, s;$$

$$\Rightarrow \text{ode} = \text{dsolve}' - 3 * y(0) - 8 * D_y(0) = 0, t$$

$$\Rightarrow F = \text{subs}(f, \{\text{laplace}(y(t), t, s)\}, y);$$

$\text{ode} =$

$$\Rightarrow f = \text{subs}(F, \{'y(0)'\}, 'D(y)(0)', 'D(D(y)(0))');$$

$$3 * \exp(-s*t) - s^2 * \exp(-3*t) + 2$$

$$\Rightarrow y = \text{solNP}(f, 'y')$$

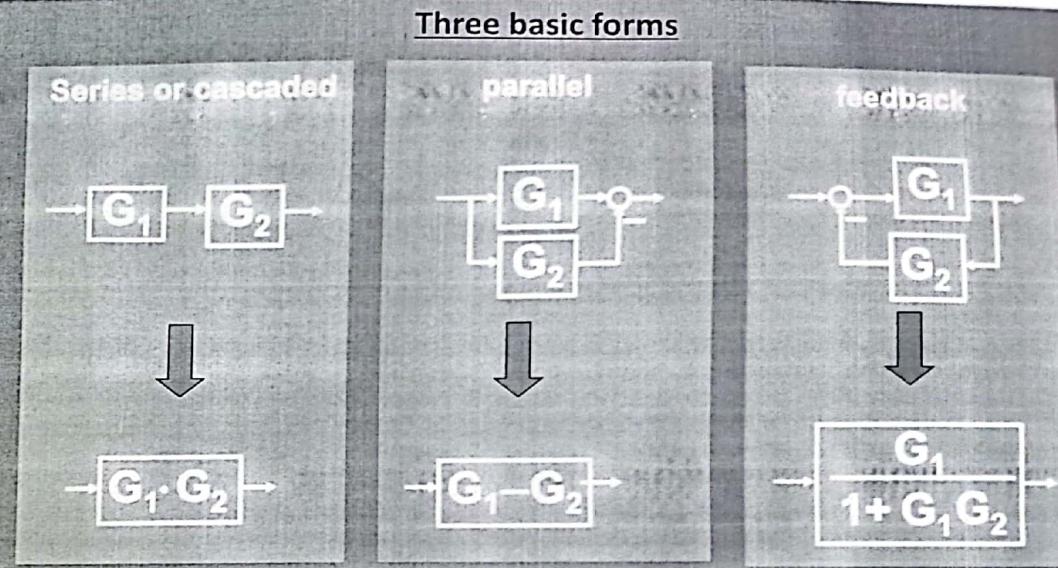
$y =$

$$3 * \exp(-s*t) - s^2 * \exp(-3*t) + 2$$

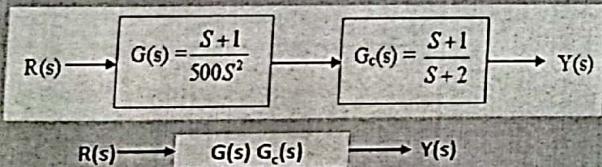
initial conditions \Rightarrow $y(0) = 0$ \Rightarrow $s = 0$
 $y'(0) = 0$ \Rightarrow $-3 * \exp(-3*t) + 2 = 0$

Lec-07

Block diagram reduction techniques



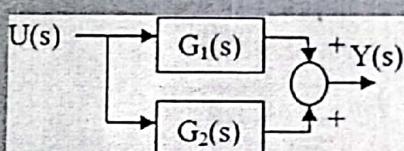
Block diagram Series or cascaded blocks reduction technique



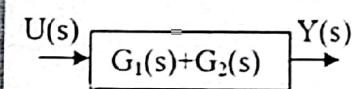
```
% transfer function G
num_G = [1 1];
den_G = [500 0 0];
% transfer function G_c
num_Gc = [1 1];
den_Gc = [1 2];
% transfer function G_all
[num_Gall, den_Gall] = series (num_G, den_G, num_Gc, den_Gc);
printsys (num_Gall, den_Gall)
```

$$Y(s)/R(s) = \frac{s^2 + 2s + 1}{500s^3 + 1000s^2}$$

Block diagram Parallel reduction Technique



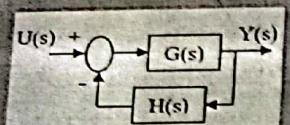
$$G_1(s) = \frac{3s+6}{s^2+7s} \quad G_2(s) = \frac{5}{s^2+2s+10}$$



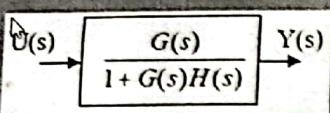
```
% transfer function G1
num_G1 = [3 6];
den_G1 = [1 7 0];
% transfer function G2
num_G2 = [5];
den_G2 = [1 2 10];
% transfer function G_all = G1 + G2
[num_Gall, den_Gall] = parallel (num_G1, den_G1, num_G2, den_G2);
printsys (num_Gall, den_Gall)
```

$$\frac{3s^3 + 17s^2 + 77s + 60}{s^4 + 9s^3 + 24s^2 + 70s}$$

Block diagram Feedback reduction technique



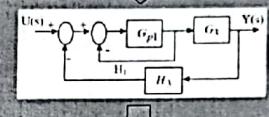
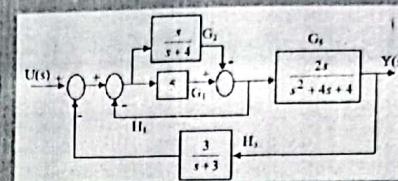
$$G(s) = \frac{3s + 6}{s^2 + 7s} \quad H(s) = \frac{s + 2}{s + 10}$$



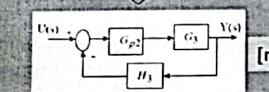
```
% transfer function G
num_G = [3 6];
den_G = [1 7 0];
% transfer function H
num_H = [1 2];
den_H = [1 10];
% transfer function G_all = G / 1+G*H
[num_f, den_f] = feedback (num_G, den_G, num_H, den_H, -1);
printsys (num_f, den_f)
```

num/den =

$$\frac{3s^2 + 36s + 60}{s^3 + 20s^2 + 82s + 12}$$

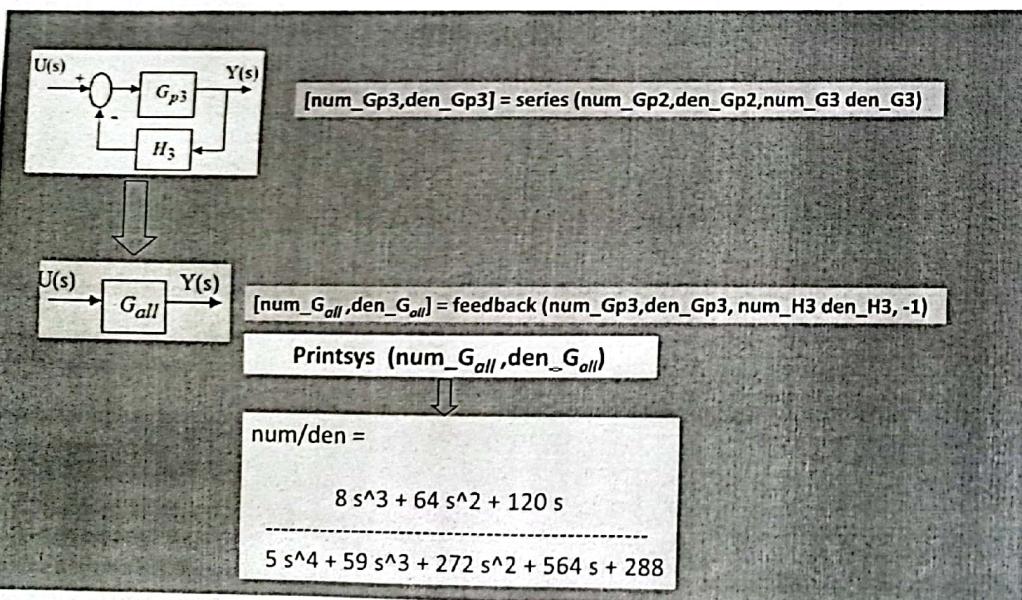


```
[num_Gp1, den_Gp1] = parallel (num_G1, den_G1, -1* num_G2, den_G2)
```

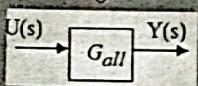


```
[num_Gp2, den_Gp2] = feedback (num_Gp1, den_Gp1, num_H1, den_H1, -1)
```

```
num_G1 = [5]
den_G1 = [1]
num_G2 = [1 0]
den_G2 = [1 4]
num_G3 = [2 0]
den_G3 = [1 4 4]
num_H1 = [1]
den_H1 = [1]
num_H3 = [3]
den_H3 = [1 3]
```



```
[num_Gp3, den_Gp3] = series (num_Gp2, den_Gp2, num_G3, den_G3)
```



```
[num_G_all, den_G_all] = feedback (num_Gp3, den_Gp3, num_H3, den_H3, -1)
```

Printsys (num_G_all, den_G_all)

num/den =

$$8s^3 + 64s^2 + 120s$$

$$\frac{8s^4 + 59s^3 + 272s^2 + 564s + 288}{5s^4 + 59s^3 + 272s^2 + 564s + 288}$$

Exam matlab

Your answer must clear; you can send m.file or screen shot:

1. Make subplot(3,3,n) the time $t=0:0.01:2*\pi$:
 - use command plot to plot sin wave in position(1)
 - use command plot to plot cos wave in position(2) and change color of line and its shape
 - use command plot to plot cos and sin in the same figure in position(3) and make legend
 - repeat the previous point by put label for x-axis(time) and label y-axis (signal) in position(4,5,6)
 - plot the function $y^2 = 5x$ position(7,8,9)
2. solve this equation with two method (matrixes and command solve) make sure the result is correct

$$\begin{aligned} x + y + z &= 2 & 2x + 3y - z &= 8 \\ x - y - z &= -8 \end{aligned}$$

3. Solve all differential equation and show the difference in answer

- (i) $y'' + y' - 2y = 0$, with $y(0) = 1$ and $y'(0) = 2$;
- (ii) $y'' + 2y' + 4y = 0$, with $y(0) = 2$ and $y'(0) = 1$;
- (iii) $y'' + 4y' + 4y = 0$, with $y(0) = 3$ and $y'(0) = 1$.

4. Make differential to x time and y again for this function and substitute with $x=2$ and $y=3$

- $F = x^2 + y^3 + xy$
- $F = 2x^2 + \frac{300}{x^3} + \frac{300}{y^3}$

5. Make integration to x for this function

$$\int \frac{x^3 e^{x^2}}{(x^2 + 1)^2} dx$$

$$\int_1^2 y^2 + y^{-2} dy$$

$$\int_0^1 \int_{1-x}^{1-x^2} xy dy dx.$$

Hint (makes the first integration and saves in variable and makes the other integration)

6. Solve this limit:

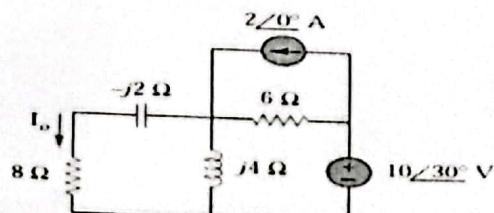
- $\lim_{x \rightarrow 4} \frac{x^2 - 7x + 12}{x - 4}$

- $\lim_{x \rightarrow 0} x \sin\left(\frac{1}{16\pi x}\right)$

• |

7. Application: solve this circuit given equation of current
Abdelrahman Farghly

Good Luck



$$(8+2i)I_1 - (4i)I_2 = 0$$

$$(-4i)I_1 + (6+4i)I_2 - (6)I_3 = \frac{1}{i}$$

$$I_3 = -2$$

Required the three current (I_1, I_2, I_3) in this equation.

8. Programming

Doctors in the control after collect the result of six subject, you need to monitor the result(number) so he request from you to help them by making a program to establish the table as shown and after you made the table also continue the program to tell them the degree of all student as (Excellent-very good-.....etc)

num	S1	S2	S3	S4	S5	S6
1	120	90	80	128	130	40
2	140	130	90	143	138	45
3	100	110	60	98	120	30
4	60	90	75	80	100	40
5	130	140	110	134	135	48

Num=indicate the number of student in section

S= indicate to the subject

S1=subject from (150)

S2=subject from (150)

S3=subject from (100)

S4=subject from (150)

S5=subject from (150)

S6=subject from (50)

Required

Neglect the row of subject(s) and column of number (num) in programming when you enter the matrix .I need matrix with result as shown in table only.

- Establish the matrix with programming.
- degree of all student as (Excellent-very good-.....etc) only from total result not individual subject

Abdelrahman Farghly

Good Luck

Hint (sum result as shown $((120+90+80+128+130+40)/750)$ and show the degree for example display Excellent) ↴

Plot the degree in relation with student number