FUNDAMENTALS OF MATLAB

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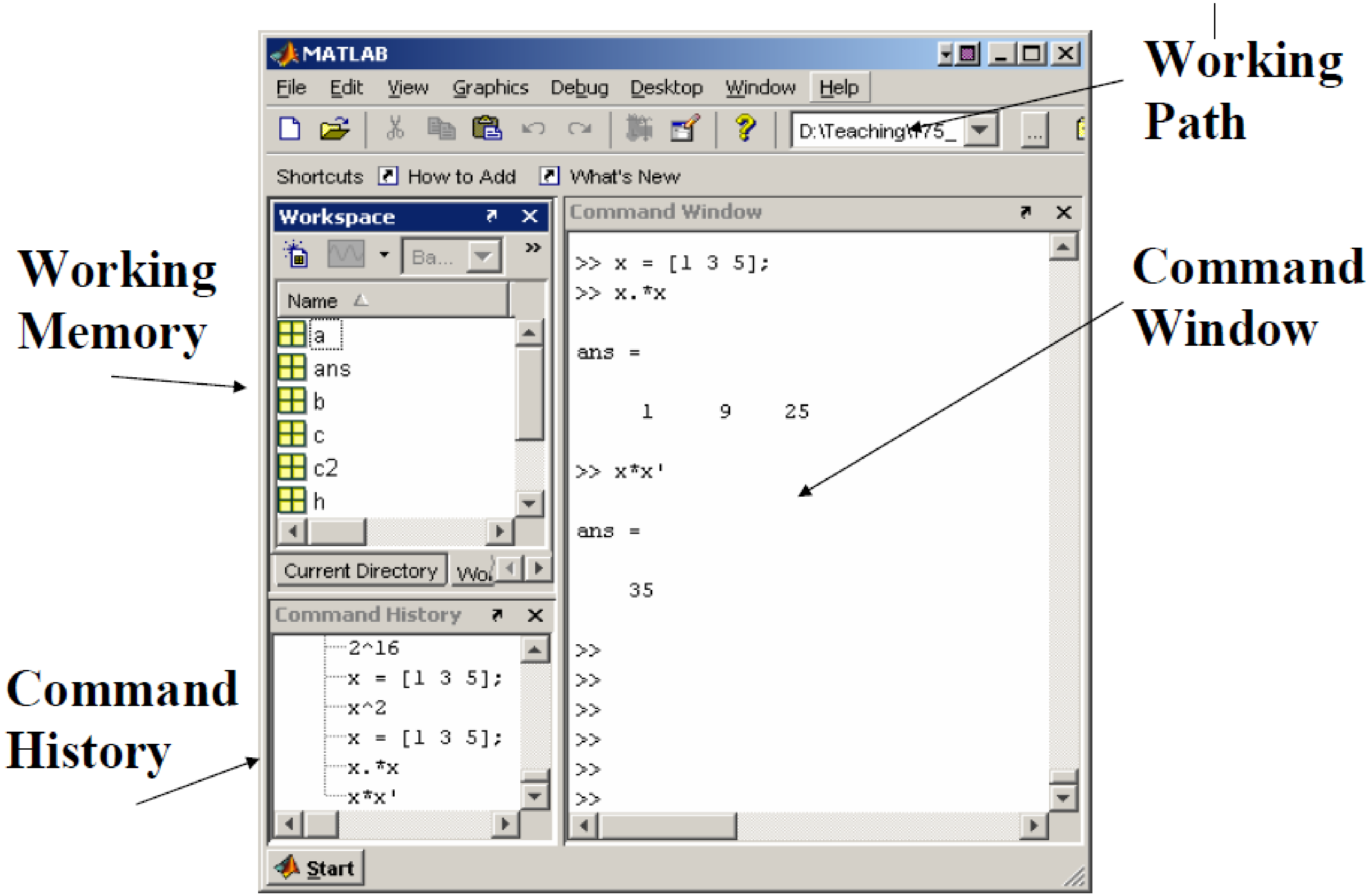
OUTLINE

- Vectors and vector operations
- Matrix and matrix operations
- Simple plotting
- 2D-3D Plotting capabilities of MATLAB

MATLAB GUI



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MATLAB
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Command History
2^16
x = [1 3 5];
x^2
x = [1 3 5];
x.*x
x*x'
Command Window
>> x = [1 3 5];
>> x.*x
ans =
1 9 25
>> x*x'
ans =
35
Start

Vectors in MATLAB

This command creates a row vector

```
a = [1 2 3]

a =
     1     2     3
```

Vectors in MATLAB

```
b = [1;2;3]

b =

     1
     2
     3
```

Vectors in MATLAB

Command **length** returns the number of components of a vector

```
length(a)

ans =

     3
```

Vectors in MATLAB

The *dot operator*. plays a specific role in MATLAB. It is used for the componentwise application of the operator that follows the dot operator

```
a.*a

ans =
        1         4         9
```

Vectors in MATLAB

The *dot operator*. plays a specific role in MATLAB. It is used for the componentwise application of the operator that follows the dot operator

```
a.^2

ans =
     1     4     9
```

Vectors and vector operations

Componentwise division of vectors **a** and **b** can be accomplished by using the *backslash operator* \ together with the dot operator **.**

```
a.\b'

ans =
      1           1           1
```

Vectors and vector operations

```
a = a'

a =

     1
     2
     3
```

Vectors and vector operations

```
dotprod = a'*b
```

```
dotprod =
    14
```

Vectors and vector operations

The *cross product* of two three-dimensional vectors is calculated using command cross.

```
b = [-2 1 2];
```

Vectors and vector operations

```
b = [-2 1 2];

cp = cross(a,b)

cp =
      1      -8      5
```

MATRICE OPERATIONS

```
A = [1 2 3;4 5 6;7 8 10]

A =

     1     2     3
     4     5     6
     7     8    10
```

MATRICE OPERATIONS

```
A = [1 2 3;4 5 6;7 8 10]

A =
     1     2     3
     4     5     6
     7     8    10
```

```
A(:)

ans =
     1
     4
     7
     2
     5
     8
     3
     6
    10
```

The *colon operator* : stands for *all columns* or *all rows*. For the matrix **A** from the last example the following command

MATRICE OPERATIONS

To delete a row (column) use the *empty vector operator* [ ]

```
A(:, 2) = []

A =

     1     3
     4     6
     7    10
```

MATRICE OPERATIONS

Second column of the matrix **A** is now deleted. To insert a row (column
creating matrices and vectors

```
A = [A(:,1) [2 5 8]' A(:,2)]
A =
     1     2     3
     4     5     6
     7     8    10
```

MATRICE OPERATIONS

```
A = [1 2 3;4 5 6;7 8 10]

A =
     1     2     3
     4     5     6
     7     8    10
```

MATRICE OPERATIONS

Note that the *semicolon operator* **;** separates the rows. To extract a submatrix **B** consisting of rows 1 and 3 and columns 1 and 2 of the matrix **A** do the following

```
B = A([1 3], [1 2])
```

```
B =

     1     2
     7     8
```

MATRICE OPERATIONS

To interchange rows 1 and 3 of **A** use the vector of row indices together with the colon operator

```
C = A([3 2 1],:)
```

```
C =
        7     8    10
        4     5     6
        1     2     3
```

MATRICE OPERATIONS

A*A

MATRICE OPERATIONS

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

MATRICE OPERATIONS

```
A*A

"??? Error using ==> *
Inner matrix dimensions must agree.
```

generates an error message.

Solving systems of linear equations by matrix operations

$$8x_1+x_2+6x_3=7.5$$
$$3x_1+5x_2+7x_3=4$$
$$4x_1+9x_2+2x_3=12$$

Solving equations

A=[8,1,6;3,5,7;4,9,2];

B=[7.5,4,12]’

X=A\b (you should use left slash)

Or

X=linsolve(A,B)

Inverse of a matrix

MATLAB function **inv** is used to compute the inverse matrix.

Let the matrix **A** be defined as follows

```
A = [1 2 3;4 5 6;7 8 10]

A =
     1     2     3
     4     5     6
     7     8    10
```

Inverse of a matrix

```
B = inv(A)

B =
   -0.6667   -1.3333    1.0000
   -0.6667    3.6667   -2.0000
    1.0000   -2.0000    1.0000
```

Verify that B is the inverse of A!!

```
A*B

ans =
    1.0000         0   -0.0000
         0    1.0000         0
         0         0    1.0000
```

In a similar way one can check that **B*A = I**.

Basic plotting

```
x = 0:pi/40:4*pi;
plot(x, sin(x))
```

`title('text')` writes the text as a title at the top of the graph.

`xlabel('horizontal')` labels the *x*-axis.

`ylabel('vertical')` labels the *y*-axis.

Basic plotting

```
plot(x, y, '--')

plot(x, y, 'o')
```

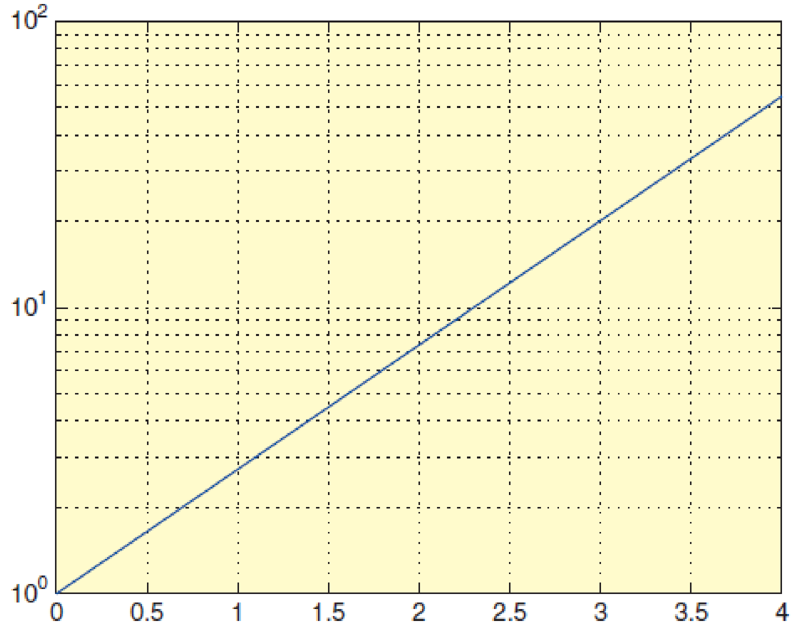
Basic plotting

```
plot(x,sin(x), x, cos(x), 'om--')
```

```
axis( [xmin, xmax, ymin, ymax] )
```

Basic plotting

```
x = 0:0.01:4;
semilogy(x, exp(x)), grid
```



Simple 3D mesh plotting

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

$$0 \le x \le 5, \quad 0 \le y \le 5.$$

Set up the grid in x-y space

```
[x y] = meshgrid(0:5);
```

```
[x y] = meshgrid(0:0.25:5);
```

You can set up the grid in x-y space with a fine mesh

Simple 3D mesh plotting

$$z = x^2 - y^2 \quad 0 \le x \le 5, \quad 0 \le y \le 5.$$

Define surface in x-y-z space in MATLAB

```
z = x.^2 - y.^2
```

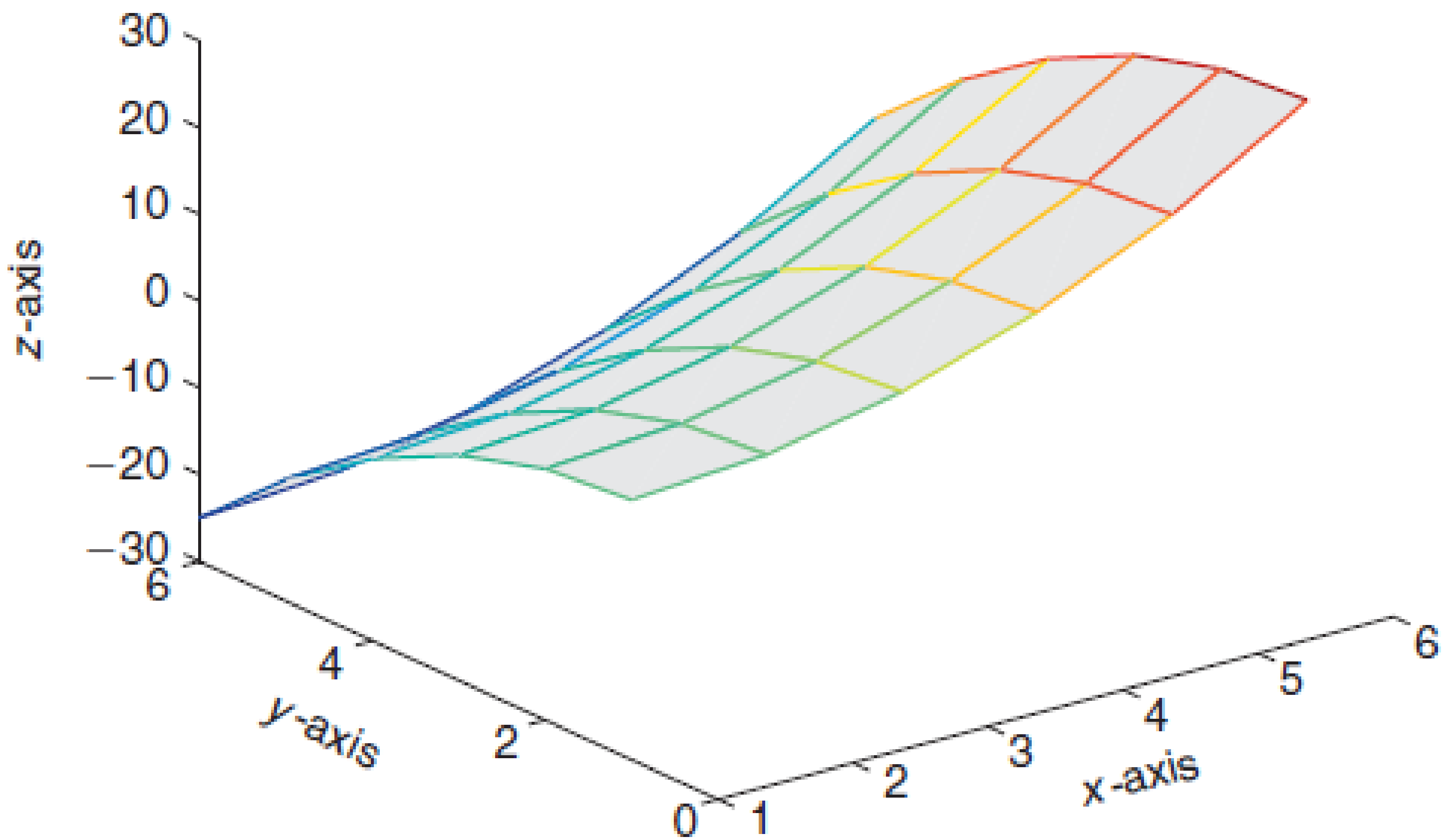
```
mesh(z)
```

```
[x y] = meshgrid(0:0.25:5);
```

You can set up the grid in x-y space with a fine mesh

Simple 3D mesh plotting

$$z = x^2 - y^2 \qquad 0 \le x \le 5, \quad 0 \le y \le 5.$$




```
[x y] = meshgrid(0:0.25:5);
```

You can set up the grid in x-y space with a fine mesh

Thank you for your patience

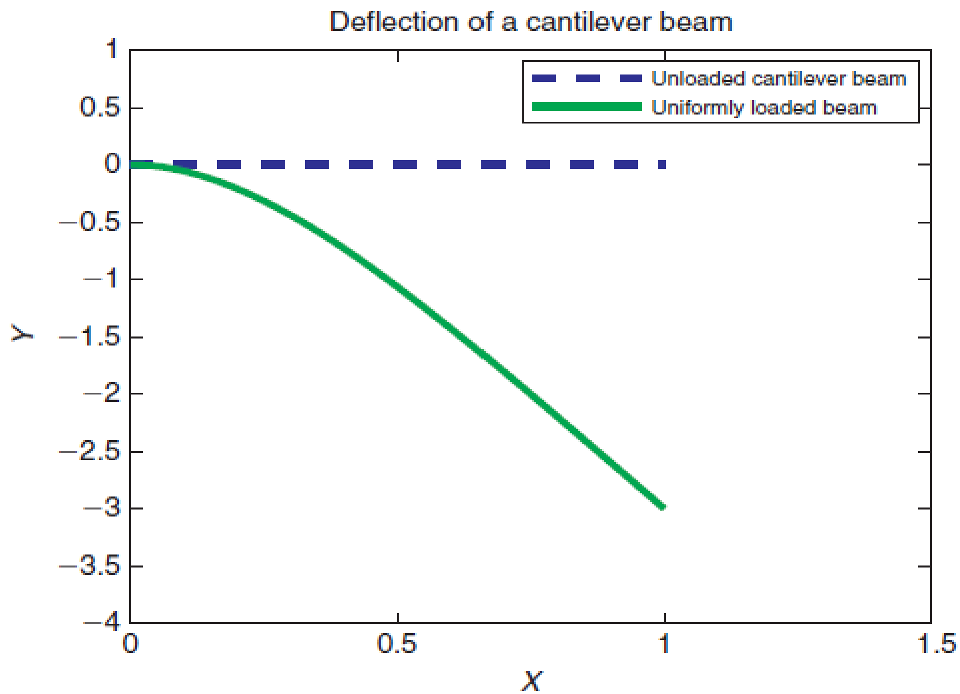
Questions welcome

TASK 1

CANTILEVER BEAM

For a uniformly loaded span of a cantilever beam attached to a wall at $x = 0$ with the free end at $x = L$, the formula for the vertical displacement from $y = 0$ under the loaded condition, with y the coordinate in the direction opposite that of the load, can be written as follows:

$$Y = \frac{y\,24EI}{wL^4} = -(X^4 - 4\,X^3 + 6\,X^2),$$



Task 2

$$M = \begin{pmatrix} 1 & 0 & 0 \\ 0 & j & 1 \\ j & j+1 & -3 \end{pmatrix},$$

1. Expand the matrix M to a 6×6 matrix V of the form

$$V = \begin{pmatrix} M & M \\ M & M \end{pmatrix}.$$

2. Delete row 2 and column 3 from the matrix V (reduced matrix $V23$).
3. Create a new vector $z4$ from row 4 of the matrix V.
4. Modify the entry $V(4,2)$ in the matrix V to $j+5$.

Task 3

Calculate the values of the signal (function)

$$s(t) = \sin(2\pi 5t)\cos(2\pi 3t) + e^{-0.1t}$$

for a time vector of times between 0 and 10 with a step size of 0.1.