Matlab.
Sesion 1

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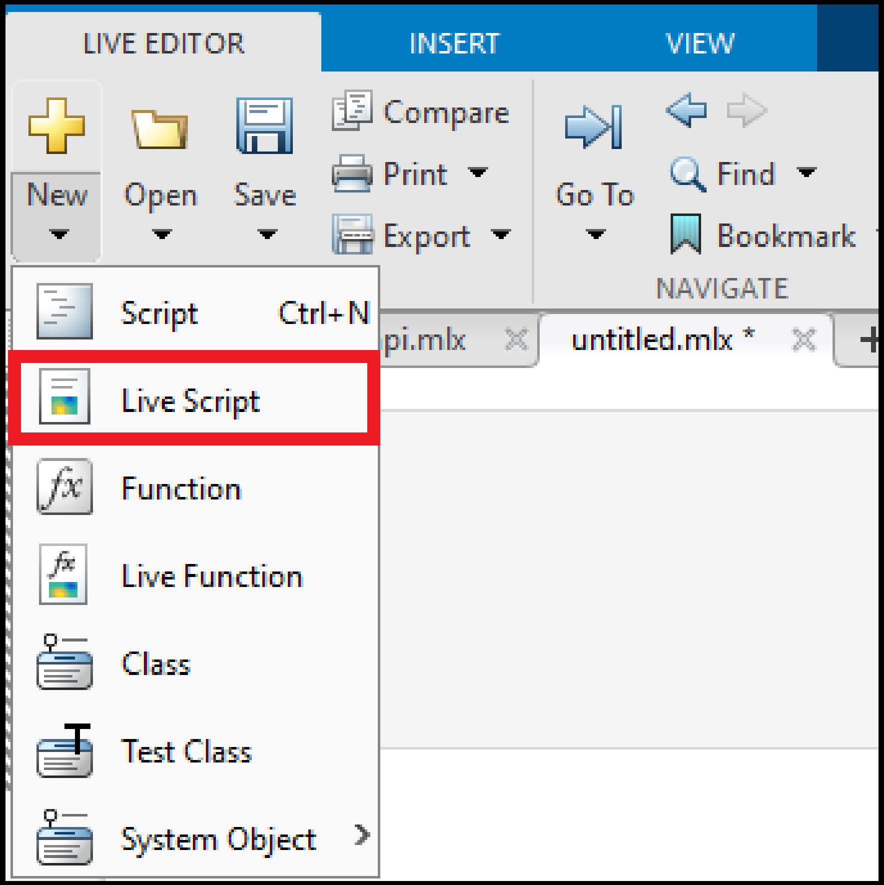
FIRST STEPS



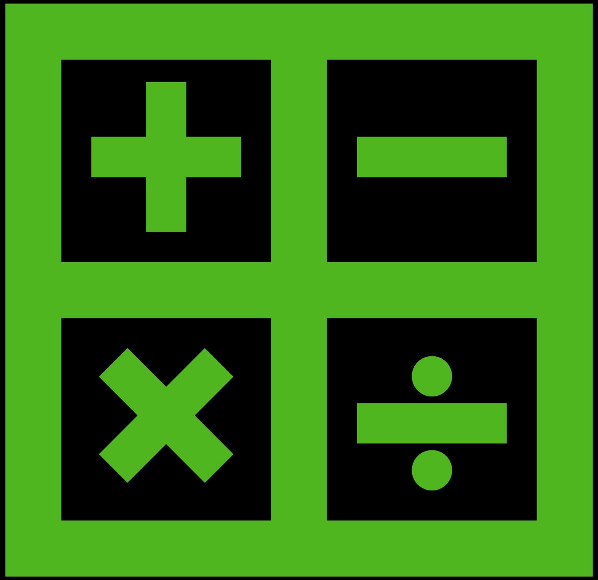
You can see the execution of your code in the same window and delete it.

You can execute your code or a part of it (Run Code or Run Section).

All the code can be saved as a pdf file.

BASICS CALCULATIONS IN MATLAB

BASICS OPERATIONS



- Addition: +
- Subtraction: -
- Multiplication: * --->careful
- Division: /
- Exponentiation: ^
- Number π: pi
- Number e: exp(1)

USUAL FUNCTIONS

abs(x), sqrt(x),
exp(x), log(x),
sin(x), cos(x),
tan(x), asin(x),
acos(x), atan(x)

Examples:

Sin(0.5)	ans = 0.4794
Log2(3)	ans = 1.5850
Sqrt(4)	ans = 2

Introduction: Exercise 1

Compute $e^{-3} \cdot \sin^4\left(\frac{1}{\sqrt{2}}\right)$, that is, $e^{-3} \cdot \left(\sin\left(\frac{1}{\sqrt{2}}\right)\right)^4$

Hint:

exp(-x)   sin(x)   sqrt(x)

Introduction: Exercise 1

```
exp(-3)*(sin(1/sqrt(2)))^4
```

```
ans = 0.0089
```

WHAT IF I NEED MORE DECIMAL NUMBERS?

- We can use vpa(x,n).

N = decimal number

X

N

```
vpa(exp(-3)*(sin(1/sqrt(2)))^4,20)
```

```
ans = 0.0088674633037051642237
```

Introduction: Exercise 2

a) 1/0, 0/0, inf/inf, inf/0

```
1/0
ans = Inf
0/0
ans = NaN
inf/inf
ans = NaN
inf/0
ans = Inf
```

b) realmax, realmin, 10^40! (factorial of 10^40), 2^(-5000)

```
realmax
ans = 1.7977e+308
realmin
ans = 2.2251e-308
factorial(10^40)
ans = Inf
2^(-5000)
ans = 0
```

c) sqrt(-4)

```
sqrt(-4)
ans = 0.0000 + 2.0000i
```

Introduction: Exercise 3

Compute $r1 = (x + y) + z, \quad r2 = x + (y + z)$ in the following cases:

(i) $x = 1,\ y = -5, z = 6$

(ii) $x = 10^{30},\ y = -10^{30},\ z = 1$

Why are the answers different?

Introduction: Exercise 3

a)

```
x = 1;
y = -5;
z = 6;

% Compute r1
r1 = (x + y) + z

% Compute r2
r2 = x + (y + z)
```

b)

```
x = 10^30;
y = -10^30;
z = 1;

% Compute r1
r1 = (x + y) + z

% Compute r2
r2 = x + (y + z)
```

VECTORS IN MATLAB

- Vectors in this tool are usually defined by brackets [ ]

  For example, x=[4,1,3] or x =[4 1 3]

- The most important commands are:
  - sum(x) sum of the coordinates
  - min(x),max(x) find minimum or maximum coordinates
  - length(x) total number of coordinates of the vector
  - x(n) to find a certain coordinate

Vectors: Exercise 4

Generate by using : and compute the number of coordinates of the following vectors

a) a = [3, 3.01, 3.02, . . . , 4]

```
a = 3:0.01:4
```

```
length_a = length(a)
```

```
length_a = 101
```

b) b = [−7, −6.5, −6, ..., 6, 6.5, 7]

c) c = [4, 3, 2, .., −1, −2]

Vectors: Exercise 5

5) Create a vector with all the integer numbers between -345 and 117, including both numbers. Then, find how many coordinates it has, the sum of all the components and the value of the 20th coordinate of the vector.

(Hint: you can define vectors with the pattern firstNumber:increment:lastNumber)

You can name your vector whatever you want (a, v, my_vector...)

REMEMBER:

- sum(x)
- length(x)
- x(n)

Vectors: Exercise 5

First, we define the vector

```
my_vector=-345:117

  my_vector = 1×463
      -345  -344  -343  -342  -341  -340  -339  -338  -337  -336  -335  -334  -333  -332  -331  -330  -329  -328  -327  ...
```

Vectors: Exercise 5

By doing this, we find how many coordinates it has

```
num_coords=length(my_vector)
```

```
num_coords = 463
```

Vectors: Exercise 5

Then, we find the sum of all the components

```
total_sum=sum(my_vector)
```

```
total_sum = -52782
```

Vectors: Exercise 5

Finally, we find the value of the 20th coordinate

```
value_20th=my_vector(20)
```

```
value_20th = -326
```

SUMMATORIES IN MATLAB

- We need the Symbolic Math Toolbox extension
- Important commands:
  - sym("number or variable") -> Creates a symbolic expression
  - When we do operations with "sym" the result will be exact and not approximate
  - syms k n -> Defines symbolic variables
  - s=symsum(k * 5^k, k, 1, n) -> Is like: $\sum_{k=1}^{n} k \cdot 5^k$
  - With this command we obtain the sum of the summatory

Summatories: Exercise 6

$$\sum_{k=1}^{n} \frac{2k+1}{k^2(k+1)^2}$$

```
syms k n
s_a = symsum((2*k + 1) / (k^2 * (k + 1)^2), k, 1, n)
```

```
s_a =
```

$$1 - \frac{1}{(n+1)^2}$$

Summatories: Exercise 6

$$\sum_{k=1}^{n}(2k-1)(2k+1)$$

```
syms k n
s_c = symsum((2*k - 1)*(2*k + 1), k, 1, n)
```

s_c =

$$\frac{4n^3}{3}+2n^2-\frac{n}{3}$$

Summatories: Exercise 6

$$\sum_{k=1}^{n}(4k^2 - 1)$$

```
syms k n
s_d = symsum((4*k^2 - 1), k, 1, n)
```

```
s_d =
```

$$\frac{2n\,(2n+1)\,(n+1)}{3} - n$$

Summatories: Exercise 6

$$\sum_{k=1}^{n}(2k-1)(2k+1)$$

$$\sum_{k=1}^{n}(4k^2-1)$$

Do you think there is a relationship between these two?

```
expand(s_d)

ans =
```

$$\frac{4n^3}{3}+2n^2-\frac{n}{3}$$

YES

- **use expand("name of the summatory")**

GRAPHS IN MATLAB

- For the function f (x) defined with syms f(x) we can:
  - Plot its graph over an interval [a,b] with:

    fplot(f, [a,b])

    With or without grid:

    fplot(f,[a,b]), grid on

- If you want to plot more than one function on one graph:
  - Hold on

    Let us plot all the graph together
  - Hold off

    Disables this previous option

Graphs: Exercise 7

(7) Plot in the same drawing the graphs of the functions $y = e^{-3x}$ and $y = x^2$ over $[0, 1]$.

REMEMBER:

- Put syms f(x) before starting to create graphs
- e=exp(^)
- Fplot(f,[a,b])
- grid on
- hold on
- hold off

Graphs: Exercise 7

```
syms f(x)

% We define the functions
f(x) = exp(-3*x)
```

f(x) = e^{-3x}

```
g(x) = x^2
```

g(x) = x^2

Graphs: Exercise 7

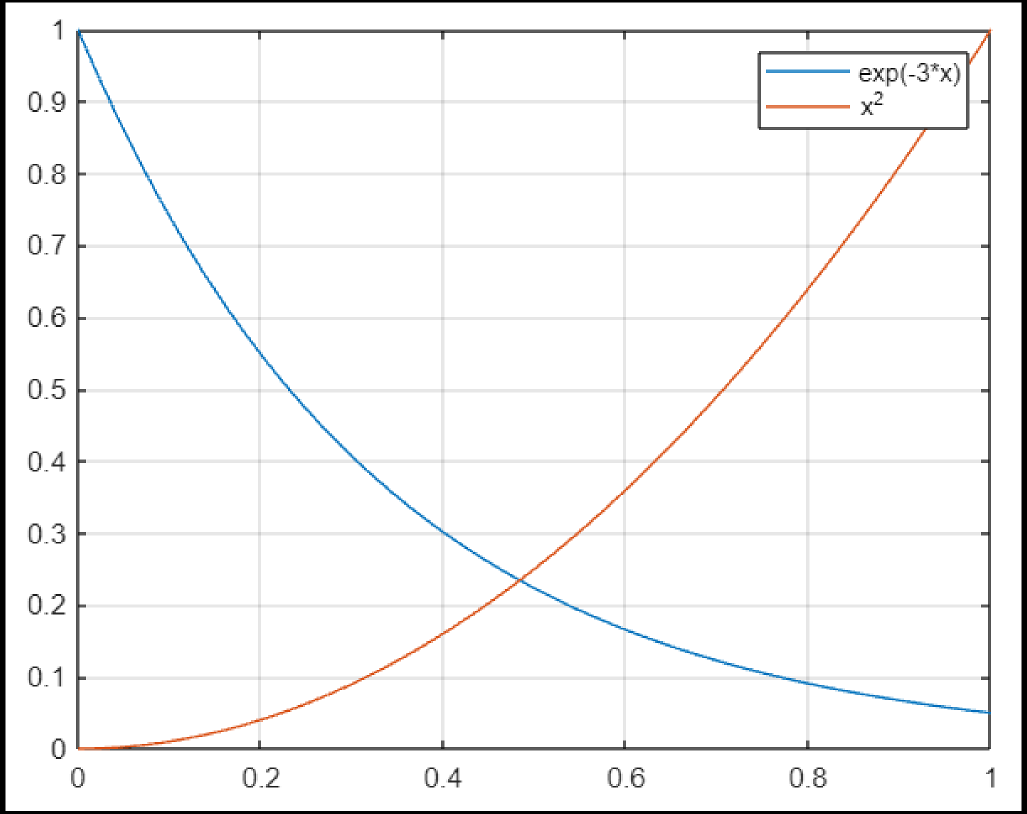
```
% We create the 1st graphic
fplot(f, [0, 1])
grid on
hold on  % We mantain the 1st graphic waiting for more graphics

% We create the 2nd graphic
fplot(g, [0, 1])

hold off
legend('exp(-3*x)', 'x^2') %We add a legend, because now we have 2 functions
```

Graphs: Exercise 7

FINAL SOLUTION



Graphs: Exercise 8

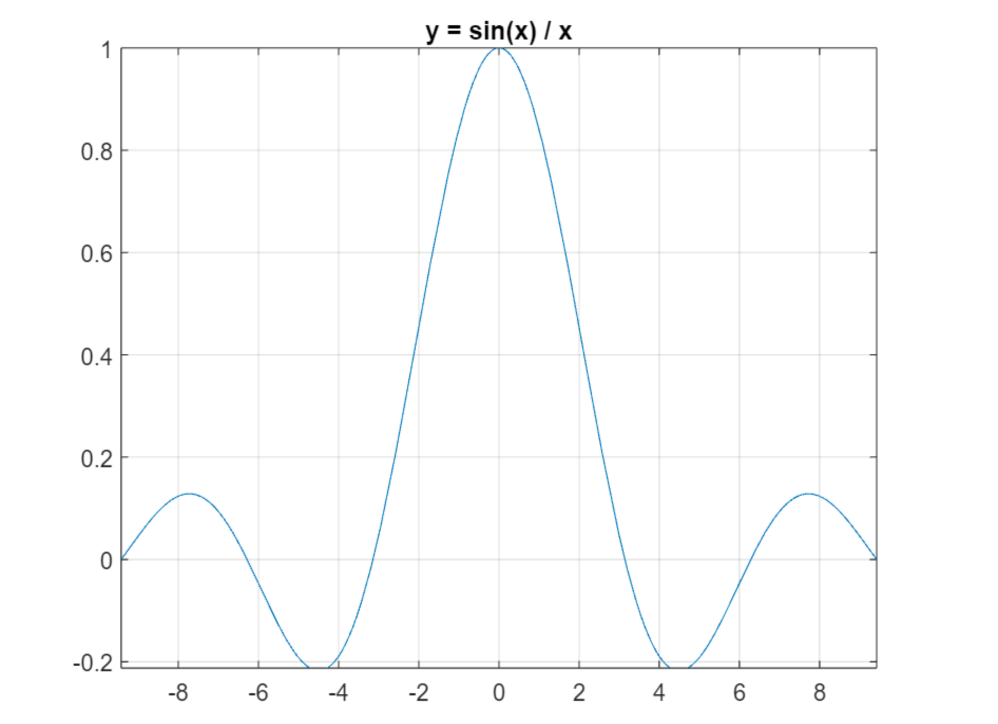
(8) Plot the following functions over the corresponding intervals:

(ii) $f(x) = \dfrac{\sin(x)}{x}$ over $[-3\pi, 3\pi]$

```
% Plot 1
syms f1(x)
f1(x) = 1 / sqrt(1 + x^2);
fplot(f1, [-5, 5]);
grid on
title('y = 1 / sqrt(1 + x^2)')
```

Graphs: Exercise 8

(8) Plot the following functions over the corresponding intervals:



Graphs: Exercise 8

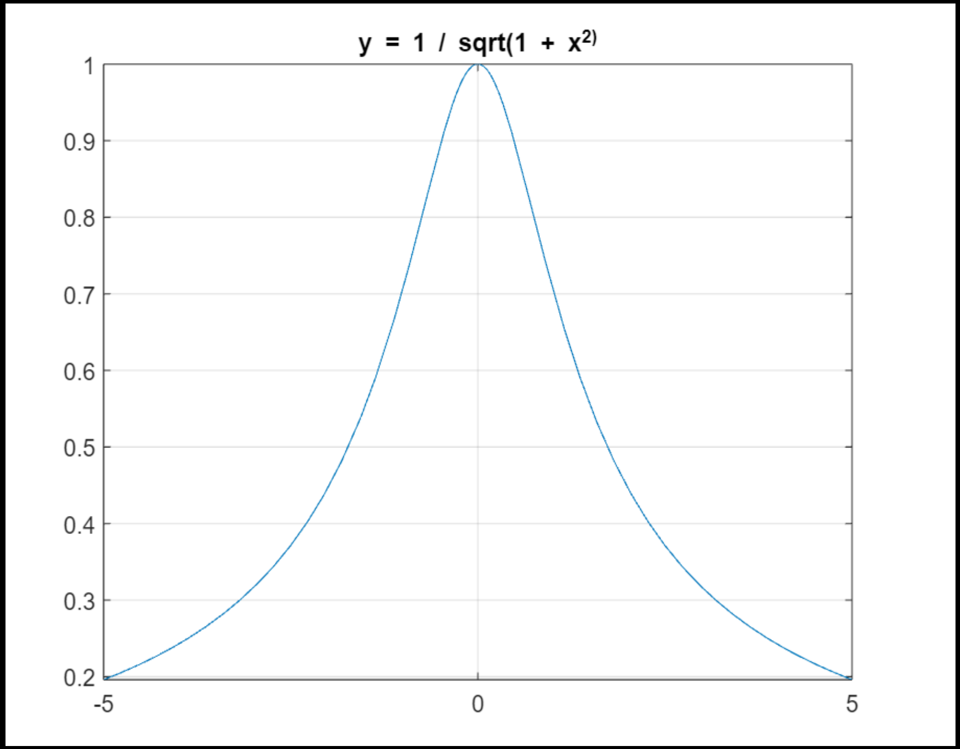
(8) Plot the following functions over the corresponding intervals:

(i) $f(x) = \frac{1}{\sqrt{1+x^2}}$ over $[-5, 5]$

```
% Plot 2
syms f2(x)
f2(x) = sin(x) / x;
fplot(f2, [-3*pi, 3*pi]);
grid on
title('y = sin(x) / x')
```

Graphs: Exercise 8

(8) Plot the following functions over the corresponding intervals:



Graphs: Exercise 8

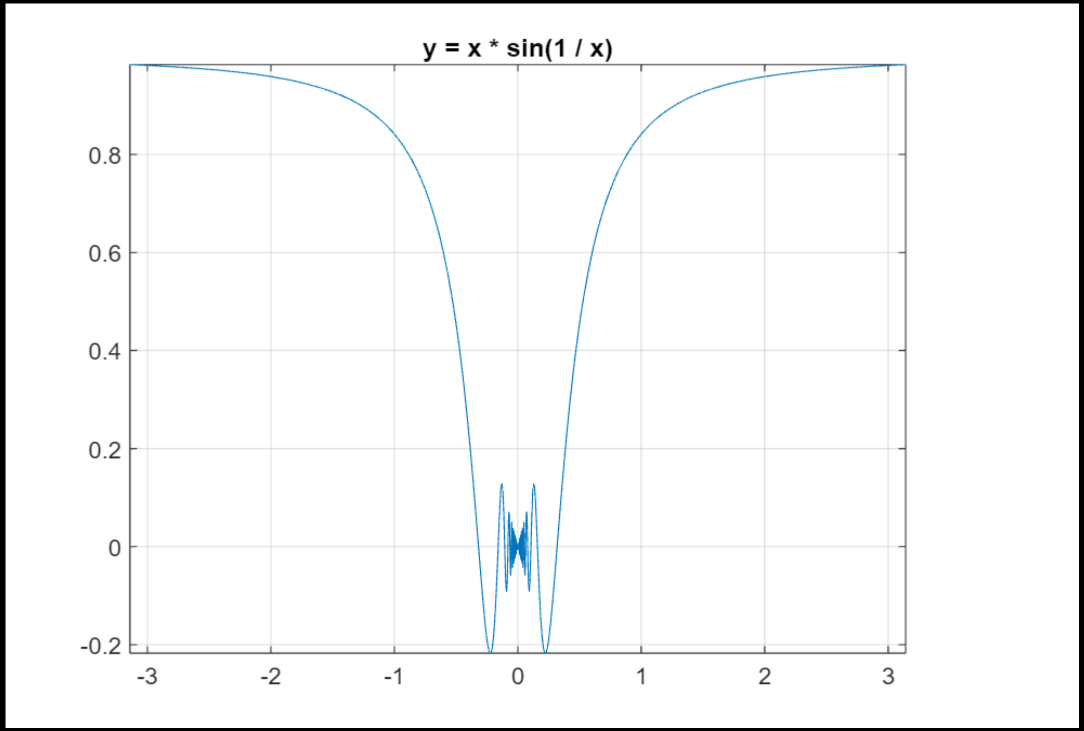
(8) Plot the following functions over the corresponding intervals:

(iii) $f(x) = x \cdot \sin\left(\frac{1}{x}\right)$ over $[-\pi, \pi]$

```
% Plot 3
syms f3(x)
f3(x) = x * sin(1 / x);
fplot(f3, [-pi, pi]);
grid on
title('y = x * sin(1 / x)')
```

Graphs: Exercise 8

(8) Plot the following functions over the corresponding intervals:



POLYNOMIALS IN MATLAB

- An n-degree polynomial can be defined in matlab
- Important commands:
  - pol1=[1,0,-8,-6,10] -> Defines this polynomial: $x^4 - 8x^2 - 6x + 10$
  - roots(pol1) -> Gives an approximation of all the roots of pol1
  - vpa(ans, "number of decimals") -> After roots(pol), you can put this command to make the roots have the number of decimals that you want

Polynomials: Exercise 9

Define the polynomials $2x^5 + 3$ and $x^3 + 2x - 1$ and compute their approximate roots with 20 decimal digits. Are these roots real or complex?

Polynomials: Exercise 9

- Define:

```
poly1 = [2, 0, 0, 0, 0, 3]
```

```
poly1 = 1×6
     2     0     0     0     0     3
```

```
poly2 = [1, 0, 2, -1]
```

```
poly2 = 1×4
     1     0     2    -1
```

Polynomials: Exercise 9

- Compute:

```
roots(poly1)
```

```
ans = 5×1 complex
   -1.0845 + 0.0000i
   -0.3351 + 1.0314i
   -0.3351 - 1.0314i
    0.8774 + 0.6374i
    0.8774 - 0.6374i
```

```
vpa(ans, 20)
```

```
ans =
```

$$\begin{pmatrix} -1.0844717711976983 31 \\ -0.33512020721998847517 + 1.0313939447357176604\,\mathrm{i} \\ -0.33512020721998847517 - 1.0313939447357176604\,\mathrm{i} \\ 0.87735609281883730759 + 0.63743651363750442052\,\mathrm{i} \\ 0.87735609281883730759 - 0.63743651363750442052\,\mathrm{i} \end{pmatrix}$$

Polynomials: Exercise 9

- Compute:

```
roots(poly2)
```

```
ans = 3×1 complex
   -0.2267 + 1.4677i
   -0.2267 - 1.4677i
    0.4534 + 0.0000i
```

```
vpa(ans, 20)
```

ans =

$$\begin{pmatrix} -0.22669882575820116122 + 1.4677115087102241553\,\mathrm{i} \\ -0.22669882575820116122 - 1.4677115087102241553\,\mathrm{i} \\ 0.45339765151640387675 \end{pmatrix}$$

THE END

Thanks!