Mathematics for Engineers 1.

Ágnes Baran and Pál Burai

Seminar
Sets, functions, Matlab basics

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Sketch the graph of the following functions!

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(d)* $f : \mathbb{R} \to \mathbb{R},$

$$f(x) = \begin{cases} x + 1, & \text{if } x < 0 \\ \sqrt{2x+1}, & \text{if } 0 \leq x \leq 4 \\ \frac{x}{2} + 1 & x > 4 \end{cases}$$

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MATLAB

MATLAB = ,,Matrix laboratory”

Detailed description and help: http://www.mathworks.com/help/

Literature: Stoyan Gisbert (editor), MATLAB, Typotex, 2008

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>> cos(0)
ans =
      1
```

If it is not otherwise designated the result is assigned to the `ans` variable.

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>> a=3+4
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>> a=3; b=4; c=a+b;
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We can ask the value of the variable typing its name in the command line:

```
>> c
c =
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```

The name of a variable

- It musts start with a letter, it can contains letters, numbers and underscores. **Small and capital letters are distinguished.** Use only the letters of the English alphabet.
- The key words of Matlab cannot be a variable name (e.g. `if`, `end`, etc.), we can print out on the screen with the command `iskeyword`.

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- We can delete variables with the command `clear` (e.g. `clear a,b` cancels the variables `a` and `b`). The command `clear all` cancels all the existing variables.

A simple figure

Exercise

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(The values should be enumerated between square brackets detached by commas or spaces.)

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>> y=[2, 1, 1.5, 3];
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```

3. step: Draw the points with the `plot` command.

```
>> plot(x,y,'*')
```

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Everything behind the % sign are not executed.
Take care of the semicolons at the end of the lines. If we forget about one, the result of the corresponding line will pop up in the command window during the execution of the process.

M-files

- Save the file into a folder which is available for Matlab. We can check the list of available folder with the command `path`, or from the Menu:

  HOME $\rightarrow$ Set Path

  The extension of all Matlab file should be `.m`, e.g. `drawing.m`

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  The extension of all Matlab file should be `.m`, e.g. `drawing.m`
- Run our program.

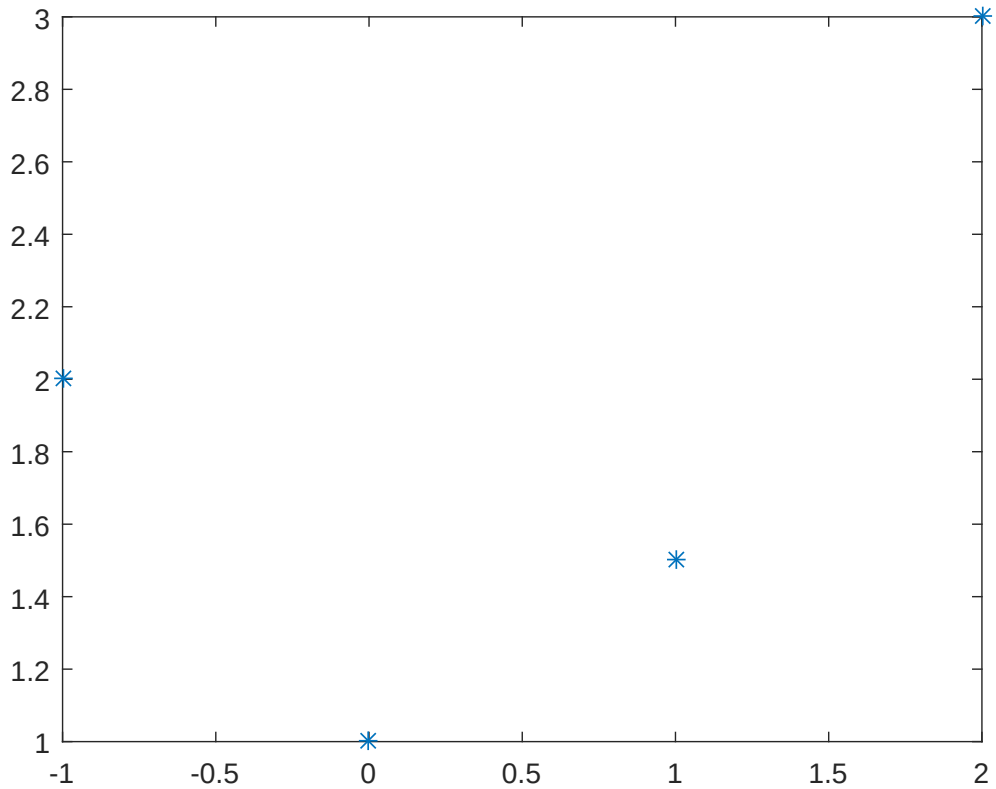
  Type the name of the file without extension into the command window:

  `>> drawing`

  or from the Menu

  EDITOR $\rightarrow$ Run

```
% plotting 4 points
x=[-1, 0, 1, 2];
y=[2, 1, 1.5, 3];
plot(x,y,'*')
```



It is easy now to modify our program: e.g.

```
% plotting 4 points
figure
x=[-1, 0, 1, 2];
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plot(x,y,'*')
axis([-1.5 2.5 0.5 3.5])
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```

If we plot a new figure, then the existing figure is overwritten in the graphic window. To avoid this we can open a new window with the figure `figure` command

The `axis` command set of the boundaries of the axis.

We can gain more information about the `plot` function typing the

```
>> help plot
```

command.

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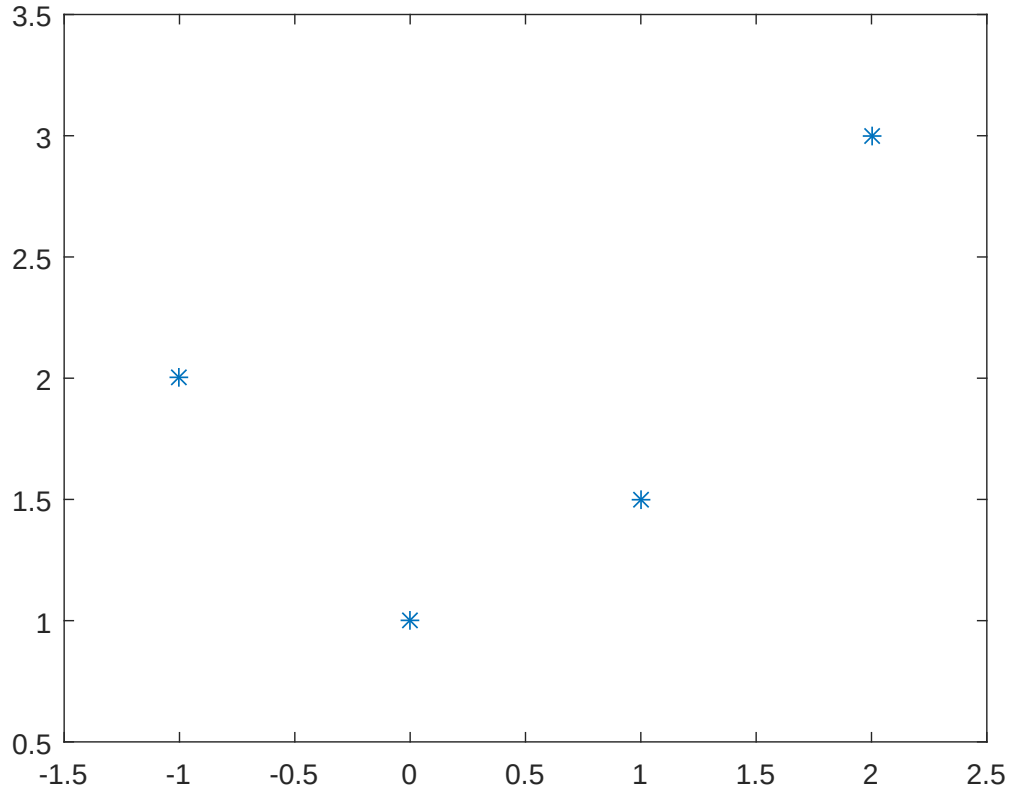

The `plot` function

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  It plots the points with coordinates x, y and joins them with sections.
- `plot(x,y,'color type and/or marker type and/or line type')`
  Plotting the points with the given marker or using the designated color or line type.

Line types

- \- continuous line (default)
- : dotted line
- - - dashed line
- -. dashed-dotted line

The `plot` function

Markers

- * star
- o circle
- + addition sign
- x cross
- s square
- d diamond
- h pentagon
- p hexagon
- < triangle pointed left
- > triangle pointed right
- $\wedge$ triangle pointed up
- $\vee$ triangle pointed down

Colours

- b blue
- r red
- g green
- k black
- w white
- y yellow
- m purple
- c cyan blue

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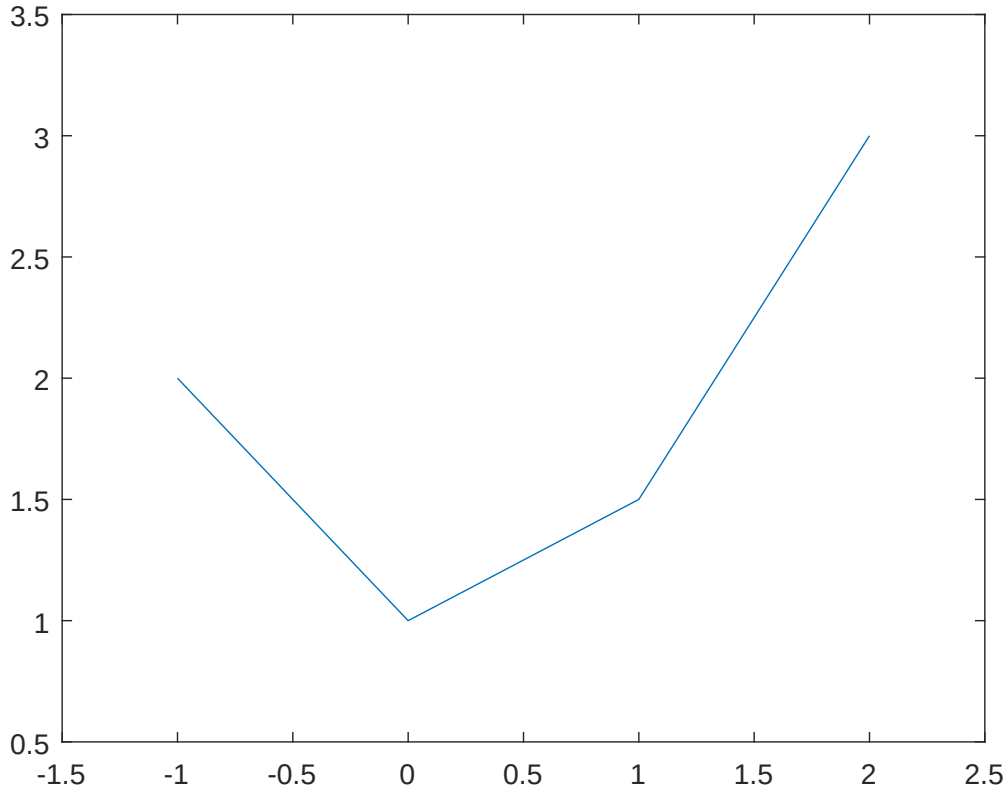

```
% plotting 4 points
figure
x=[-1, 0, 1, 2];
y=[2, 1, 1.5, 3];
plot(x,y,'-.r*')
axis([-1.5 2.5 0.5 3.5])}
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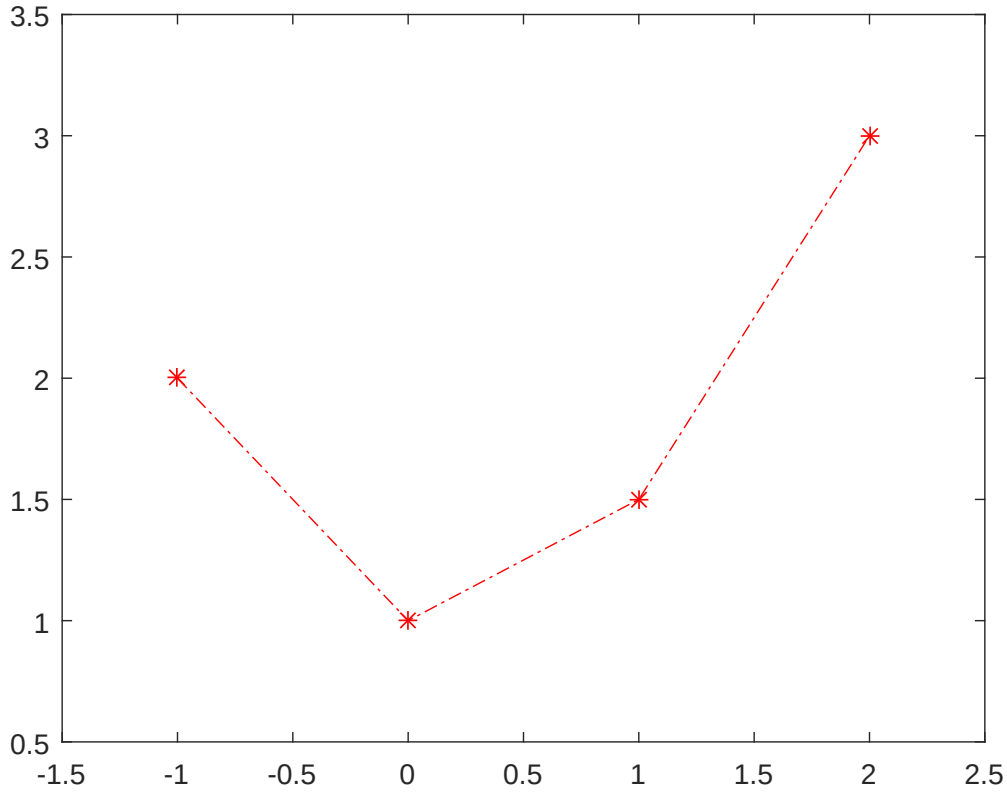

Plotting functions

Example

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Take many point of the interval $[0, 2\pi]$ using one of the following two commands:

Plotting functions

Example

Plot the function $f(x) = \sin(x)$ *over the interval* $[0, 2\pi]$*!*

We have to designate lots of points of the graph to reach a satisfactory result.

Take many point of the interval $[0, 2\pi]$ using one of the following two commands:

```
>> x=linspace(0,2*pi,50);
```

or

```
>> x=linspace(0,2*pi);
```

In the first case we get 50 equidistant points and 100 in the second one on the interval $[0, 2\pi]$.

Plotting functions

In the general case:

`x=linspace(left point of the interval, right point of the interval, number of points)`

the result will be "number of points" equidistant points, or

`x=linspace(left point of the interval, right point of the interval)`

the number of points will be 100 in this case.

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Evaluate the function at every points!

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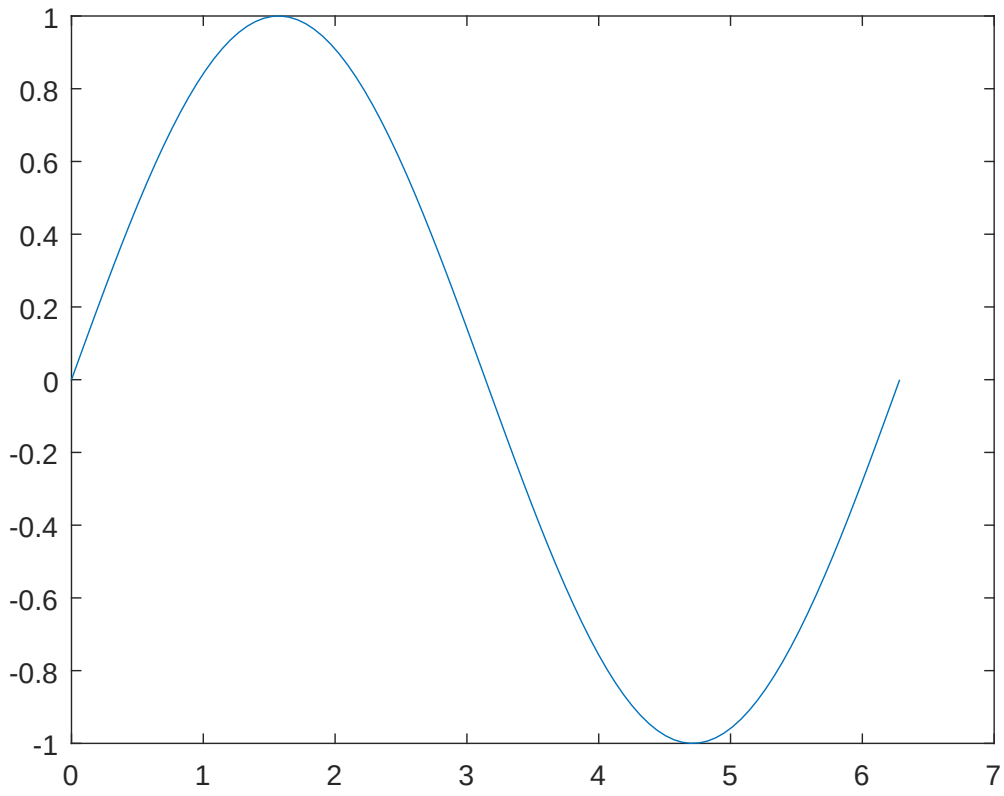
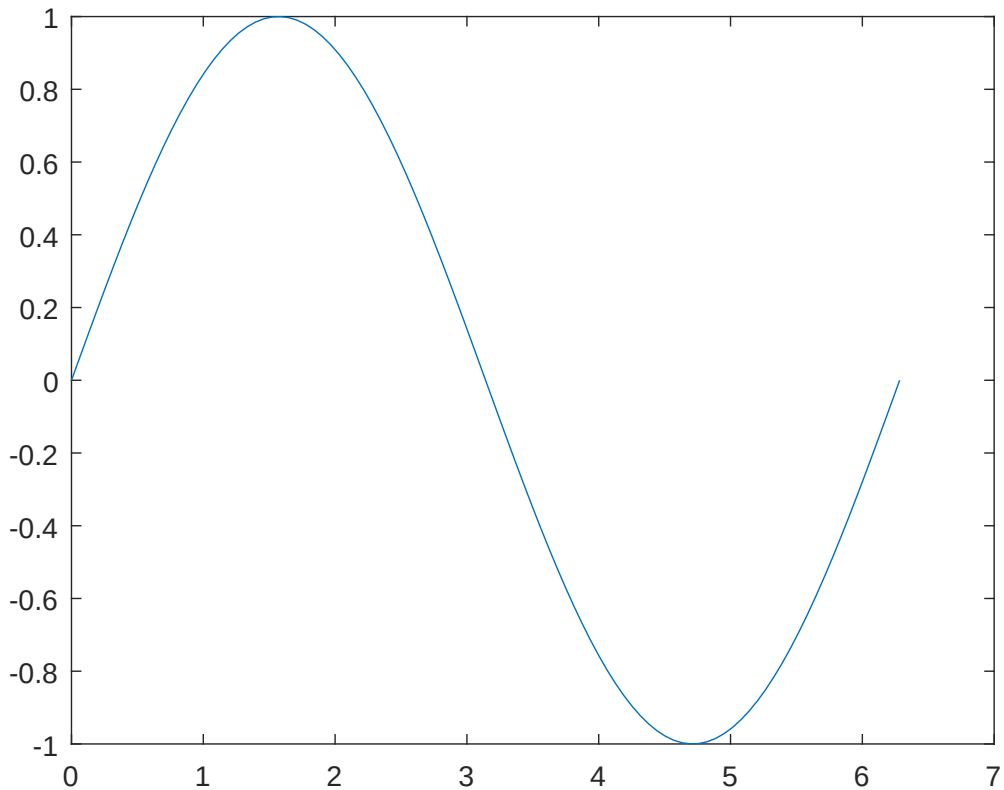
Most of the Matlab functions can call with vector argument. In this case the sin is calculated of all the coordinates of `x` and then the obtained values are stored in `y`. So, `x` and `y` has equal numbers of coordinates.

```
x=linspace(0,2*pi);
y=sin(x);
figure; plot(x,y)
```



The fplot function

```
figure;
fplot('sin',[0,2*pi])
```



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figure; plot(x,y)
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figure; plot(x,y)
```

Coordinatewise operations with vectors: If `a` and `b` are two vectors with the same number of coordinates, then

- `a+b` is the coordinatewise sum,
- `3*a` multiplies all the coordinates of `a` by 3.
- `a.*b` is the coordinatewise product,
- `a./b` is the coordinatewise ratio.
- `a.^ 2` is the coordinatewise square.

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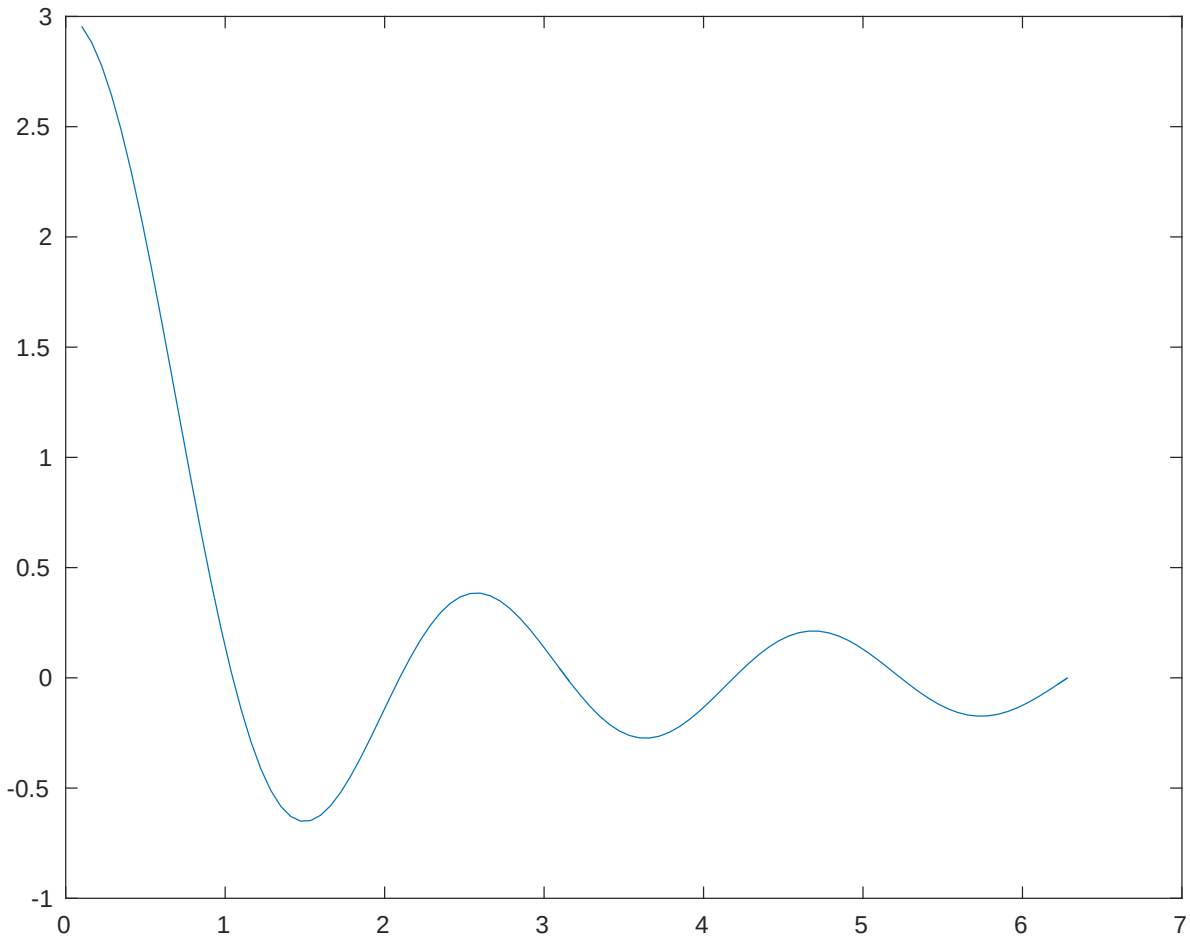
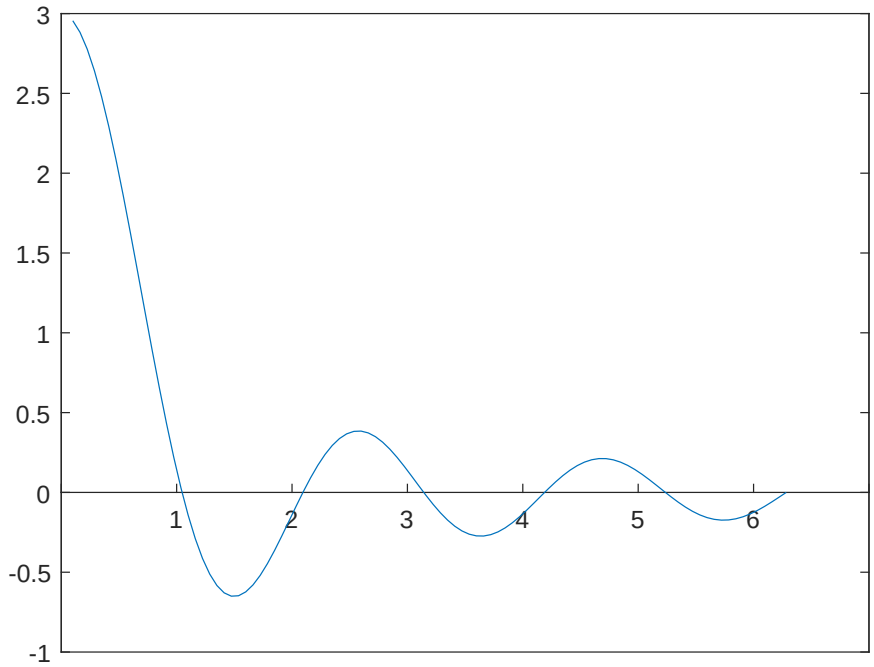
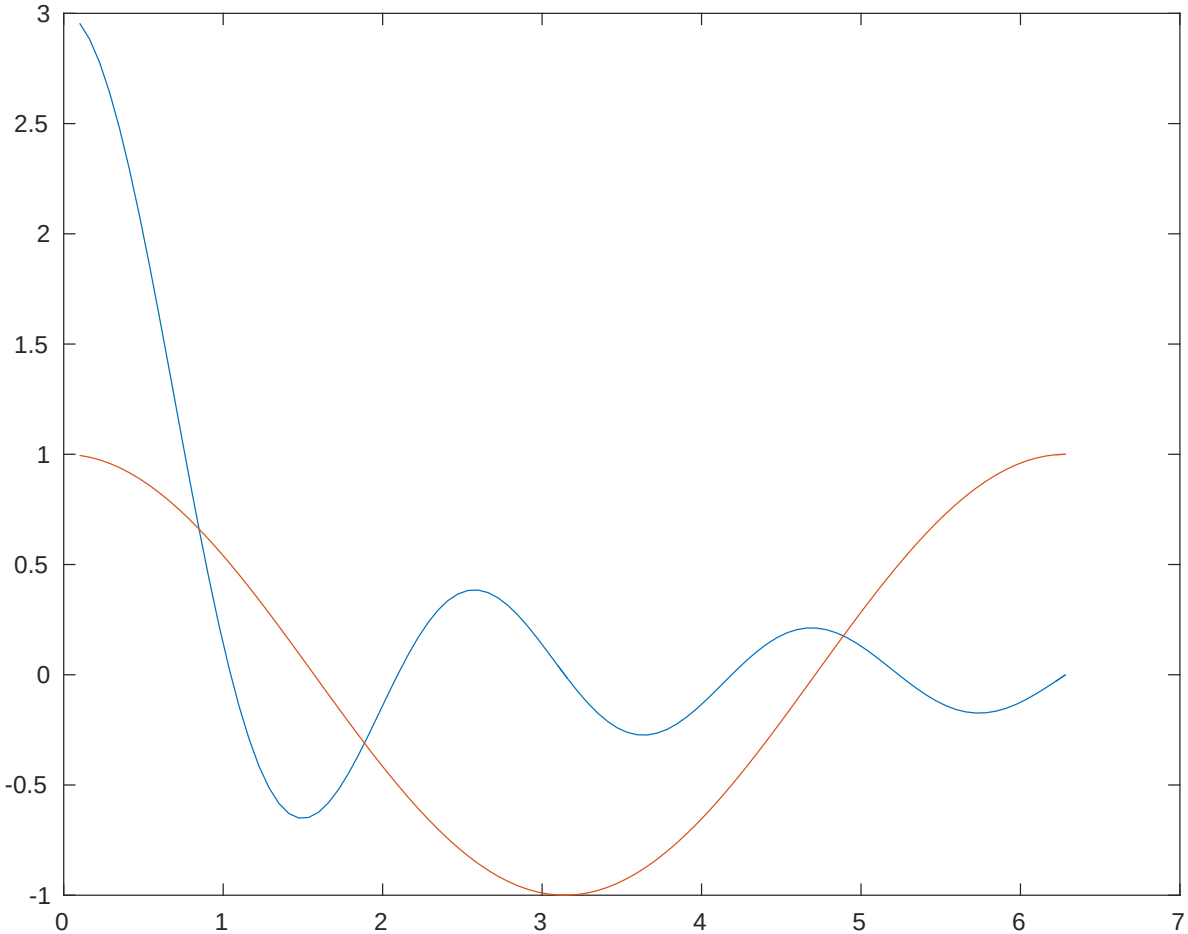


```
x=linspace(0.1,2*pi);
y=sin(3*x)./x;
figure; plot(x,y)
ax=gca;
ax.XAxisLocation = 'origin';
ax.YAxisLocation = 'origin';
```



More than one graph on one figure



More than one graph on one figure

```
x=linspace(0.1,2*pi);
y=sin(3*x)./x;
z=cos(x);
figure; plot(x,y,x,z)
```

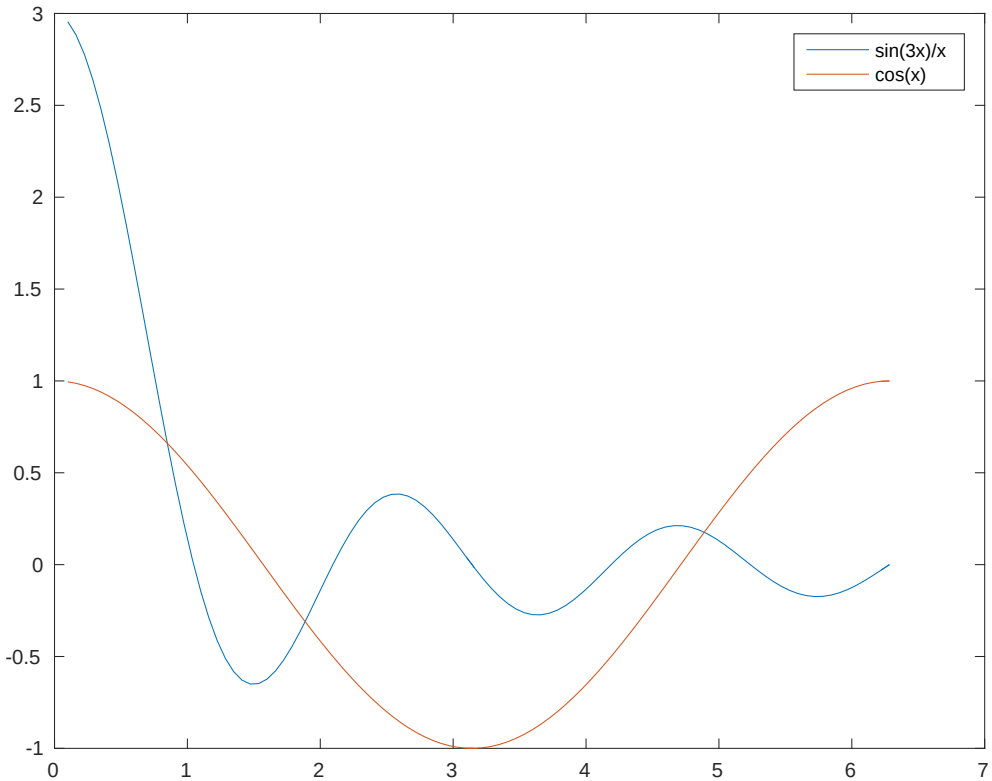
or

```
x=linspace(0.1,2*pi);
y=sin(3*x)./x;
z=cos(x);
figure; plot(x,y)
hold on;
plot(x,z)
hold off;
```

- `hold on`
  it keeps the original plot and draw the new one in the same window.

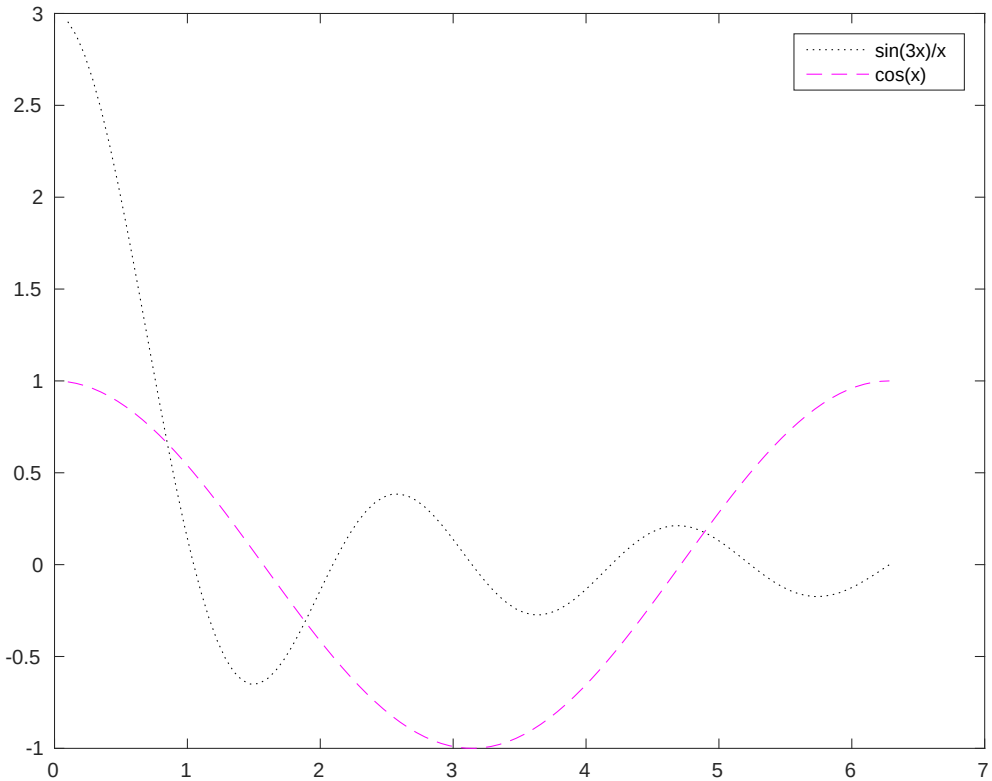
More than one graph on one figure, legend box

```
x=linspace(0.1,2*pi);
y=sin(3*x)./x;
z=cos(x);
figure; plot(x,y,x,z)
legend('sin(3x)/x','cos(x)')
```



Line type and color designation

```
x=linspace(0.1,2*pi);
y=sin(3*x)./x;
z=cos(x);
figure; plot(x,y,'k:',x,z,'m--')
legend('sin(3x)/x','cos(x)')
```



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Plot the function f over the interval T and give its properties!

(a) $f(x) = x^2$ *and* $T = [-3, 3]$

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(f) $f(x) = \cos(x)$ *and* $T = [0, 2\pi]$

(g) $f(x) = \sin\left(x - \frac{\pi}{2}\right)$ *and* $T = [0, 2\pi]$

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(g) $f(x) = \sin\left(x - \frac{\pi}{2}\right)$ *and* $T = [0, 2\pi]$

(h) $f(x) = \sin(3x)$ *and* $T = [0, 2\pi]$

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(e) $f(x) = \sin(x)$ *and* $T = [0, 2\pi]$

(f) $f(x) = \cos(x)$ *and* $T = [0, 2\pi]$

(g) $f(x) = \sin\left(x - \frac{\pi}{2}\right)$ *and* $T = [0, 2\pi]$

(h) $f(x) = \sin(3x)$ *and* $T = [0, 2\pi]$

(i) $f(x) = 3\sin(x)$ *and* $T = [0, 2\pi]$

Exercise

Plot the function f over the interval T and give its properties!

(a) $f(x) = x^2$ *and* $T = [-3, 3]$

(b) $f(x) = (x-2)^2 + 3$ *and* $T = [-3, 5]v$

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Plot the given functions in the same window!

(a) $f(x) = e^x$, $g(x) = ln(x)$,

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