Joint ICTP-IAEA College on Advanced Plasma Physics
ICTP
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Course: **Numerical methods and simulations**

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Goal of the course:

- Learn basic numerical methods in physics

    - Learn numerical software Matlab
    - Simulations of ordinary differential equations
    - Solution of nonlinear equations and systems of equations
    - Simulations of partial differential equations (if time permits)

Lecture 1: Introduction to Matlab

In Linux, first open a Console (Terminal).

Matlab is started with the command

    `matlab` (press Enter)

The basic data structures in Matlab are *matrices*. Example: The command

    `a=[1 3 2]`

creates a 1×3 row matrix. The command

    `a=[1;3;2]`

or

    `a=[1 3 2]'`

creates a 3×1 column matrix. The apostrophe (') transposes matrices.

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Assignment without output to screen: Use semi-colon after command. Example:

```
c=[2 4 3 5];     (no output to screen)
c        (writes "c=2 4 3 5")
```

Basic operations on matrices:

Add two matrices. Example

```
a=[1 3 2 4]
b=[1 1 1 1]
c=a+b
```

gives the output "c=2 4 3 5"

Element-wise multiplication:

```
a=[1 3 2 4]
b=[3 2 1 1]
c=a.*b
```

gives the output "c=3 6 2 4"

Element-wise division:

```
c=a./b
```

gives the output "c=0.3333 1.5 2 4"

Usual matrix multiplication:

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

gives the output

```
c=
6 5
10 8
```

Element-wise power:

```
c=a.^2
```

gives the output "c=1 9 4 16"

Colon notation: convenient way to make x-vectors.

```
x=(0:3)
```

gives the output "x=0 1 2 3"

```
x=(0:100)*0.1 (gives "x=0 0.1 0.2 ...9.9 10")
```

Plot a figure:

```
plot(x,sin(x))
```
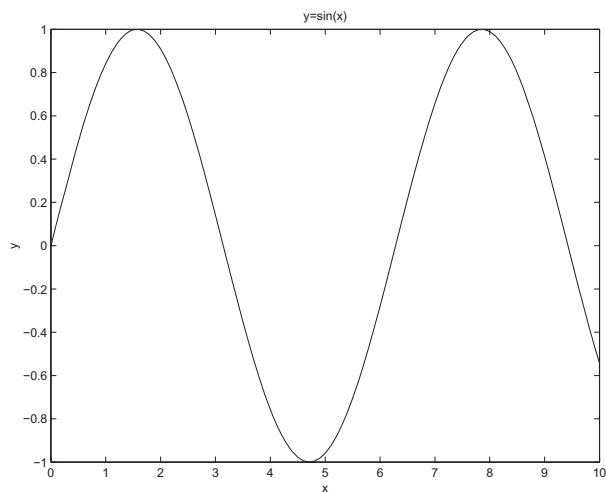
Label the x-axis:

```
xlabel('x')
```

Label the y-axis:

```
ylabel('y')
```

Make a title:

```
title('y=sin(x)')
```


Make an encapsulated PostScript (EPS) figure file:

```
print -deps fig1.eps
```

For a color figure type instead: `print -depsc fig1.eps`

In Linux, you can view the EPS file with the command:

```
gv fig1.eps
```

To produce a JPEG file:

```
print -djpeg fig1.jpg
```

View the file with the command `display fig1.jpg`

For help on in Matlab, type `help` *command*, for example

```
help print
help abs
help sin
```

Use the command

```
doc
```

to browse commands.

Create your first program in Matlab, choose from the menu
   New Script

Inside the file, write

```
disp('Hello world!');
```

then choose *Save / Save As* and File Name: `hello.m`

If you now in Matlab type

```
hello
```

then the text `Hello world!` will appear

To modify the "hello.m" program, choose *Open* from the menu, then click
on hello.m.