Lab exercises
Degree in mechanical engineering
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Some useful commands in Matlab

- An M-function, say `Fun.m`, can be written in the following way

```
function [o1,...,oM]=Fun(i1,..., iN)
%--------------------
%function body
%--------------------
return
```

  where `i1,...,iN` are input parameters and `o1,...,oM` are the output ones.

- If `f.m` is a file containing for example the function $f(x) = x^2 \sin x$, that is

```
function [y]=f(x)
  y=x.^2.*sin(x);
return
```

  So, if we know the value of `x`, the command `y=feval(@f,x)` is equivalent to `y=f(x)`. Then, one can use both of them!

- In Matlab there exist functions useful for finding zeros of a function: `fzero` and `roots`.

  `roots` computes the zeros (also complex ones) of polynomials. Call it as `roots(a)`, with `a` the vector of the polynomial coefficients (in reverse order, coefficent of higher to constant term).

  `fzero` can be called in the following way: `x=fzero(fun,x0,opt)` with `fun` specified using the symbol `@`. For example,

```
f=@(x,c) sin(x^3/c); x0=2;
sol = fzero(f,x0,[],9)
```

here `9` is the value of the parameter `c`.

To know which input and output parameters requires a function, write in the Command (the shell black window), `help fsolve` or `help roots` (or `doc fsolve/roots`).

- The pre-defined variable `varargin` allows to specify a variable number of parameters to a function. For example, if we define a function

```
function myplot(x,varargin)
plot(x,varargin{:});
return
```

we could call it as

```
myplot(sin(0:.1:1),'color',[.5 .7 .3],'linestyle',':');
```

To know the number of input parameters, Matlab has the variable

```
nargin
```

Hence, we may check and modify `myplot` as follows:

```
function myplot(x,varargin)
if nargin==0
    error('bad number of parameters')
    return
elseif nargin==1 plot(x) else
    plot(x,varargin{:})
end
return
```

- There are also the variable

```
varargout, nargout
```

that allows to have a variable number of output parameters and count them, respectively.

Solve the following problems

1. Take the function $f(x) = x^2 - \sin(x+1)$ of which we want to compute its zeros.

   - By plotting the graph of f, individuates the `two` real roots of $f(x) = 0$ and the corresponding `separation intervals`, I_{α_1} e I_{α_2}.
   - Find two convergent `iterative methods`, with iteration functions $g_i(x)$, $i = 1, 2$. For each one of them determine the number of necessary iterations. Consider `kmax=100`, as max number of iterations and, for the test on the relative error `tol=1.e-6`.
   - Compare the results with the ones obtained with `fzero`.

2. Compare the `bisection method`, and the fix point iteration method (using a suitable iteration function) for computing the only real root of

$$1 = \frac{g}{2x^2}(\sinh(x) - \sin(x)), \qquad g = 9.81\,.$$

   As before, take `kmax=100` and the tolerance `tol=1.0e-6` for the relative error.