Chapter Four

SOLVING AN EQUATION WITH ONE VARIABLE

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* An equation with one variable can be written in the form f(x)= 0.
* A solution to the equation (also called a root) is a numerical value of x that satisfies the equation.
* Graphically, a solution is a point where the function f(x) crosses or touches the x axis.
* If such a value does not exist or is difficult to determine, a numerical solution can be determined by finding an x that is very close to the solution.
* In general, a function can have zero, one, several, or an infinite number of solutions.
* **In MATLAB a zero of a function can be determined with the command (built-in function) fzero with the form:**



**Additional details on the arguments of fzero:**

• x is the solution, which is a scalar.

• function is the function to be solved. It can be entered as

 mathematical expression as a string.

The function has to be written in a standard form. For example, if the function to be solved is

 $xe^{−x}=0.2$

it has to be written as

 $f\left(x\right)=xe^{−x}−0.2=0$

If this function is entered into the fzero command as a string, it is typed as:

 $'x∗exp\left(−x\right)−0.2'$

When a function is entered as an expression (string), it cannot include predefined variables. For example, if the function to be entered is

 $f\left(x\right)=xe^{−x}−0.2$

it is not possible to define b=0. 2 and then enter

 $'x∗exp\left(−x\right)−b'$

* xo can be a scalar or a two-element vector. If it is entered as a scalar, it has to be a value of x near the point where the function crosses (or touches) the x axis.
* If xo is entered as a vector, the two elements have to be points on opposite sides of the solution. If
* f(x) crosses the x axis, then f(xo(l)) has a different sign than f(xo(2)).
* When a function has more than one solution, each solution can be determined separately by using the fzero function and entering values for xo that are near each of the solutions.
* A good way to find approximately where a function has a solution is to make a plot of the function.
* In many applications in science and engineering the domain of the solution can be estimated.
* Often when a function has more than one solution only one of the solutions will have a physical meaning.

Example 1: Solving a nonlinear equation

Determine the solution of the equation

 $xe^{−x}$=0.2

**Solution**





Additional comments:

* The fzero command finds zeros of a function only where the function crosses the x axis. The command does not find a zero at points where the function touches but does not cross the x axis.
* If a solution cannot be determined, NaN is assigned to x.
* The fzero command has additional options.

 [x fval] =fzero (function, x0)

assigns the value of the function at x to the variable fval.

* When the function can be written in the form of a polynomial, the solution, or the roots, can be found with the roots command, as explained earlier.

**Example 2 : The gas equation**



**global P T n a b R**

**R=0.08206;**

**P=6; T=323.2; n=2; a=3.59; b=0.047;**

**Vest=n\*R\*T/P;**

**V=fzero(@Waalsfun,Vest)**

**function fofx = Waalsfun( x )**

**global P T n a b R**

 **fofx=(P+n^2\*a/x^2)\*(x-n\*b)-n\*R\*T**

**end**

>>

v =

8.6613 [The volume of the gas is 8.6613 L]

**Problems**

