

# Solving Equations with Maple

## Introduction

The purpose of this lab is to find solutions to one equation.

## Solving a function or an expression algebraically

You can set an expression or function equal to another expression, function, or number inside a `solve` command. As an example, you may want to find where the following two parabolas intersect.

```
> g := 9*x^2-14;  
> h:=-x^2;  
> plot([g,h],x=-2..2);  
> solve(g=h,x);
```

The plot shows that there are two intersection points and the `solve` command finds both  $x$  values. It is good to get into the habit of naming your output so you can use it in a later command. Giving the  $x$  values a name makes it easy to plug them into the function to find the  $y$  values.

```
> ip:=solve(g=h,x);
```

Since there are two  $x$  values called  $ip$ , use `[ ]` to call up the one you want.

```
> subs(x=ip[1],g);  
> subs(x=ip[2],h);
```

Therefore the two intersection points are  $(\frac{\sqrt{35}}{5}, \frac{-7}{5})$  and  $(\frac{-\sqrt{35}}{5}, \frac{-7}{5})$ . This seems like the answer shown on the graph.

## Solving a function or an expression numerically

If you would like to find where the following function crosses the horizontal line  $y = -50$  you can try the `solve` command.

```
> j:=x->2*x^3-15*x^2-2*x+5;  
> k:=x->-50;  
> plot([j(x),k(x)],x=-3..8);
```

The graph shows there should be three answers.

```
> solve(j(x)=k(x),x);
```

AAAAAAAAAAAAAAAAARG! That is some scary output! So instead of using the algebraic `solve` try the numerical `fsolve`.

```
fsolve(j(x)=k(x),x);
```

## Some more strange output

If you want to find where the following function crosses the x-axis, just set it equal to zero.

```
> f:=theta->-1/2*theta+sin(theta);
> plot(f(theta),theta=-8*Pi..8*Pi);
> solve(f(theta)=0,theta);
```

Wow, what is that?!?! We know from the graph that there should be three answers and `solve` wasn't a great option so try `fsolve` again.

```
> fsolve(f(theta)=0,theta);
```

Where are the other two answers!? This is actually how `fsolve` usually works. It shoots for one answer and only gives that one. But you can tell `fsolve` where to look by getting an idea from the graph and typing that domain into the `fsolve` command.

```
> a:=fsolve(f(theta)=0,theta=-5..-1);
> b:=fsolve(f(theta)=0,theta=-1..1);
> c:=fsolve(f(theta)=0,theta=1..5);
```

To find the  $y$  values just plug in the names of the  $x$  values.

```
> f(a);
> f(b);
> f(c);
```

(Of course the  $y$ -values are zero!)

## Exercises

- Given the expression  $x^4 - 7x^3 + 7x^2 - 7x + 6$ ,
  - Plot the expression and in text state how many times the it crosses the x-axis.(Experiment with domain values until you find values that show the crossing points clearly.)
  - Use the Maple `solve` command to find the  $x$  values of where it crosses the x-axis (also called the roots).
  - Use the Maple `fsolve` command to find the roots.
  - State, in text, the value of the roots. Also, how are the results of `solve` and `fsolve` different in this problem?
- Given the expressions  $x^3 - 6x + 4$  and  $-x + 4$  find the intersection points. (Do not change the answers to decimals)
- Given the functions  $f(x) = \sqrt{\frac{x}{2}} \sin(x)$  and  $h(x) = e^{\frac{x}{12}} - \frac{11}{20}$  find the intersection points. (When writing your text sentence use only two decimal places for the numbers. Round correctly!)