Solving Equations on Athena

This handout focuses on several computational tools to solve equations too complicated to be done analytically. If you are comfortable with doing iterations by hand, good for you. If you have a calculator that can solve equations or some software you are already familiar with, good for you too. If you don't, this handout will give you a very quick tutorial on several softwares available on Athena: Matlab, Maple, and Mathematica.

Which one to use? I can't give a straight answer. Maple and Mathematica are, for our purpose, equivalent. They are somewhat friendlier than Matlab. On the other hand, Matlab may be more familiar to you (e.g. from 10.001) and it's more robust and versatile for other applications.

Much of what's here will make more sense if you try it out yourself. `This font` is used for what you type. Pay attention to syntax: each software has its own use of upper- vs. lower-case, "[ ]" and. "( )", "`:=`" vs. "`==`", etc. I'm assuming you're familiar with the arithmetic symbols: +, – , *, /, and ^. If you need functions such as ln( ) or exp( ), look up the help documents for each software.

Matlab

Not as friendly as Mathematica or Maple but maybe more familiar to those who took 10.001.

Access from Athena: `add matlab` followed by `matlab &`

Examples:

`solve('x^3-3*x+2=0')` gives you the three roots for $x^3-3x+2 = 0$

`[x,y]=solve('x+y=5','x^2-y=1')` solves these two equations with two unknowns, x and y

```
eqn1='x+y=5'
eqn2='x-y=1'
[x,y]=solve(eqn1,eqn2)
```

another way to solve more than one equation
(this also allows you to save your equations; see below)

Useful commands:

`more(20)`	makes Matlab pause every 20 lines for long outputs
`help` *`topic`*	gives you the help document for *topic,* e.g. `help solve` or `help general`
`who`	lists all variables
`save` *`filename`*	saves all the variables into file called *filename*
`load` *`filename`*	loads the variables again
`clear all`	clears all variables, clean slate

Maple

Has useful Help document. Watch out for the different equal signs, `:=` and `=`

Access from Athena: `add maple` followed by `maple &`

Examples:

`solve(x^3-3*x+2=0);`	gives you all the roots
`solve({x+y=1, x^2-y=-1});`	solving two equations with two unknowns.

(more)

Maple (continued)

A useful feature not so conveniently done in Matlab is to specify coefficients separately. For example:

```
a:=1; b:=-3; c:=2;
solve(a*x^2+b*x+c=0);
```

":=" for assigning values, "=" for specifying equation
gives you 1 and 2, just like above.

If you want to solve the same equation but with different a, b, and c (maybe you made a mistake in calculating them the first time around), you can simply go back up, change the values, and `solve` again.

Useful things:
You can save and load the file using the File options on the menu bar.
You can search the Help documents for specific functions, like `solve`; you can also get some usage examples.
`restart;` is a command you can use to clear all variables and functions.

Mathematica

Very similar to Maple. Watch out for the different equal signs: `=` and `==`. Also, Mathematica uses square brackets "[ ]" and first-letter uppercase for functions such as Solve[ ]

Access from Athena: `add math` followed by `mathematica &`

Mathematica has a "kernel" system where it doesn't run the lines until you tell it to, which you do by pressing **Shift-Enter** instead of just Enter.

Examples:

```
Solve[x^3-3*x+2==0,x]                [Shift-Enter]
Solve[{x+y==1, x^2-y==-1},{x,y}]     [Shift-Enter]
```

";" surpresses output, don't use

Mathematica uses == to define equations and = to assign value to a variable. Compare with Maple above:

```
a=1; b=-3; c=2;                      [Enter]
Solve[a*x^2+b*x+c==0]                [Shift-Enter]
```

Like in Maple, you can save and load your file. You can clear variables using the Clear function, e.g. `Clear[x,y,z];`

Comments

1) Learning how to use these programs is useful for later but don't let it bog you down for too long: knowing the concepts behind a problem is, for now, still more important than getting the exact correct answer.

2) Watch your units! Since you don't specify the units on the computer, make sure first that the units are right.

3) I should emphasize again the importance of syntax. You can spend hours in front of the computer, thinking your equation is wrong, while it's actually just a typo of '`:=`' for '`=`'. (And these softwares are supposed to help you save time!) If things don't work, watch out for uppercase vs. lowercase, "(" and "[", ":=" and "==', or the ";" at the end of the line, etc.

4) You can also use a spreadsheet program (like Microsoft Excel with its Goal Seek command) to solve one equation and one unknown. See "How to Solve Cubic Equation" handout at the "Useful Links" section of the 10.213 website. If you have the Solver add-in, you can use it to solve multiple simultaneous equations.