Introduction to Maple (version 12)
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Quick Help: **F1**	To toggle math/text: **F5**

Typing To get x^2 type `x^2` using the carat (`SHIFT-6`). Notice how Maple changes the expression to look the same way we mean it to look, with 2 as an exponent. Now press return. You see the Maple output in blue. Your cursor is on the next line, ready to go. The next expression we want to type in is $3x^2 - 2x + 1$. Type `3x^2` — see it change? — now type `-2x+1`. Oops! Maple thinks you are still typing in the exponent. We have to tell Maple that we are finished with the exponent before we move on. Start over (backspace, or highlight and delete) and type `3x^2` [`RIGHT ARROW`] `-2x+1`. Press return and see the result in blue.

Plots To graph in Maple 12 use the `plot` command (remember to use the right arrow when needed): `plot(x^2, x=-1..15)` will plot the graph of $y = x^2$ using -1 to 15 on the x-axis and automatically finding the appropriate scale for the y-axis. You can change the x-axis ranges in this way and still have automatic adjustment of the y-ranges. For example, click in your plot statement and change the `-1..15` to `-10..5` and press enter and you will see the scaling change.

Functions To define a function, the syntax is very important.

FOR EXAMPLE:

To define $f(x) = 2x + 7$ you will need to type: `f := x -> 2x+7` the arrow "→" is formed with a hyphen and ">" symbol.

- To evaluate for $x = 3$, type $f(3)$ and Maple returns a blue "13".
- In order to graph the function, use the plot command: `plot(f(x),x=-2..5)`
- You may also define a function using the *EXPRESSIONS* menu on the left. Choose the `f:=a->y` expression and then edit the "a" and the "y".

Solving To solve an equation, there are several options. Sometimes any of the following three will work fine for us, sometimes we find we need a specific technique.

FOR EXAMPLE:

Suppose we want to solve $2x + 7 = 8$. If we type in the equation `2x+7=8` we then see the equation in BLUE. If we right click on the equation, we will see a menu which offers "SOLVE". Choosing SOLVE opens another menu which includes the choices SOLVE, NUMERICALLY SOLVE, and NUMERICALLY SOLVE FROM A POINT. If we choose SOLVE – SOLVE, we will see Maple provide the solution in fraction form (solve gives exact symbolic answers). If we choose SOLVE – NUMERICALLY SOLVE, Maple will provide the solution in decimal form (an approximation of the solution). Typically NUMERICALLY SOLVE is more appropriate for our work, but at times the SOLVE command will provide an answer when NUMERICALLY SOLVE will not. The third way to solve an equation is to use the SOLVE – NUMERICALLY SOLVE FROM A POINT. This is actually the same as NUMERICALLY SOLVE, but we also give Maple a starting point to look for a solution (similar to what we did with *Goal Seek* in Excel). There is an example later in this intro which requires the use of SOLVE – NUMERICALLY SOLVE FROM A POINT. These techniques will be helpful in our work throughout the semester.

Intercepts Often we want to find x-intercepts (also called roots or zeros) of a function. Breakeven quantities occur where the profit is zero, so those x-coordinates are x-intercepts. We simply ask Maple to solve the appropriate equation.

FOR EXAMPLE:

Suppose you define a profit function, $P(x) = 3.50x - 175$. Carefully input: `P:=x->3.5x-175` To find the breakeven quantity, you can find the x-intercept by solving the equation $P(x) = 0$. Type into Maple: `P(x)=0` press return. Now right click on the blue equation and choose SOLVE – SOLVE or SOLVE – NUMERICALLY SOLVE. You find $x = 50$, the breakeven quantity.

NOTE: This is a good moment to mention that **MAPLE IS CASE SPECIFIC**. That means that Maple sees a completely different letter when you enter a capital "P" or a lower case "p". If you define the profit function above as it is typed and then try to solve the equation $p(x) = 0$, Maple won't understand what you want.

Special Functions Maple has some specially defined functions, as did Excel. Remember, Maple is case specific, where Excel is not.

- To evaluate the square root of a number, like $\sqrt{7}$, use `sqrt(7);`
- To use Euler's number e to a power, like e^7, use `exp(7);`

NOTE: These commands MUST be in lower case letters! You may also choose from the EXPRESSIONS menu to get these special functions.

Simultaneous Plotting To graph two functions on the same axes, we need to know the syntax.

FOR EXAMPLE:

Suppose we have the demand price model $d(x) = 7 - x$ and the supply price model $s(x) = 2x + 1$. After we define the functions in Maple, we can graph both on the same axes by typing: `plot([d(x),s(x)],x=0..10)` It is necessary to use the brackets in this command.

Points of Intersection We can find the point of intersection of two functions by using the SOLVE command(s).

FOR EXAMPLE:

Suppose we have the demand price model $d(x) = 7 - x$ and the supply price model $s(x) = 2x + 1$. We want to find the intersection, which is our market equilibrium point. Once we define our functions, we can ask Maple to solve the equation $d(x) = s(x)$. If we set them equal and solve for x, we will find the x-coordinate of the intersection, which is the market equilibrium quantity $x = 2$. To find the market equilibrium price we need to plug 2 into either equation: $d(2)$ or $s(2)$, to find the price of 5. This technique works for finding most intersections.

Approximate Solutions There are times when solve and numerical solve don't give us the solution we are looking for. In those situations, we need to tell SOLVE where to look for a solution.

FOR EXAMPLE: Here is a problem finding the intersection of two functions.

Our quest is to find the coordinates of the points of intersections of these two functions:

$$f(x) = \frac{300}{x+8} \qquad \text{and} \qquad g(x) = \frac{100x - x^2}{200}$$

Be careful entering the functions, remember to use the right arrow or parentheses as needed. Graph both functions together for `x=0..100`. Now set the functions equal by typing: `f(x)=g(x)`. If we execute, highlight, and SOLVE – SOLVE, we get multiple lines of difficult to interpret information. Lets try again with SOLVE – NUMERICALLY SOLVE and execute to get 24.46667030. But this is only one x-coordinate solution and we can see from the graph that there are two. There is another near 100, so we tell SOLVE – NUMERICALLY SOLVE FROM A POINT where to find the solution by giving it a starting point near the intersection, say 100. Maple will find the other x-coordinate solution of 93.70416035. Now we have the two x-coordinates for the points of intersection. We need only plug in those x-values to either of the functions to get the y-values.

Practice Problem Here's a practice problem

- Demand price: $d(q) = -20q + 2700$
- Variable cost per unit: 300
- Fixed costs: 800

Graph the cost, revenue and profit functions on the same axes and find any breakeven quantity(s) on the interval $0 \leq q \leq 150$.

Here's one way to do it:

(1) `d:=q->-20q+2700`

(2) `c:=q->300q+800`

(3) `r:=q->d(q)*q`

(4) `p:=q->r(q)-c(q)`

(5) `plot([c(q),r(q),p(q)],q=0..150)`

(6) `p(q)=0`

(7) SOLVE – NUMERICALLY SOLVE

(8) SOLVE – NUMERICALLY SOLVE FROM A POINT (Choose 120)

The breakeven quantities are 0.334 and 119.666

Quick Tips For quick help on a particular topic use "?" For example: To find out more about the "plot" command type: `? plot` and press return. Maple will open up a help box on plotting. To delete a line use CTRL DELETE (control+delete).