

IODE Syntax for Mathematical Expressions - A Brief Guide

These notes are basically from the IODE project and are written by the IODE team at the University of Illinois, P. Brinkmann, R. Jerrard, and R. Laugesen.

The purpose of these notes is to guide the student through some basic Matlab syntax for mathematical expressions that are used with IODE. More details may be found on the Matlab help manual and the IODE manual located at:

<http://www.math.uiuc.edu/iode/documentation.html>

- (1) Simple Expressions:

<code>2*x</code>	means	$2x$
<code>(x^3-1)/6</code>	means	$(x^3 - 1)/6$
<code>pi</code>	means	π

Note that every multiplication must be written as a `*`!

- (2) Matlab has certain mathematical expression built-in. Here are some common ones:

<code>exp(x)</code>	exponential function	e^x
<code>log(x)</code>	natural logarithm	$\ln x$
<code>log10(x)</code>	base 10 logarithm	$\log_{10} x$
<code>abs(x)</code>	absolute value	$ x $
<code>sqrt(x)</code>	square root	\sqrt{x}
<code>sign(x)</code>	sign function equals 0 or ± 1	$x/ x $, if $x \neq 0$
<code>sin(x)</code>	sine function	$\sin x$
<code>cos(x)</code>	cosine function	$\cos x$
<code>tan(x)</code>	tangent function	$\tan x$
<code>asin(x)</code>	inverse sine function	$\arcsin x$
<code>acos(x)</code>	inverse cosine function	$\arccos x$
<code>atan(x)</code>	inverse tangent function	$\arctan x$

Other trig functions have similar syntax as do the hyperbolic trig functions.

- (3) Formulas: Combining the above expression to form formulas can be tricky. Basically, always remember to use parentheses and `*` for multiplication. For example, if you want to write:

$$3x^2 \cos^2 3x$$

you would type `(3*(x^2))*(cos(3*x))^2`. If you enter a function $f(x, y)$ into the ODE direction field component of IODE and you get a syntax error, try entering a simple piece of the equation and building up the more complicated formula step-by-step.

- (4) Some more examples: `sin(exp(y))^4` means $\sin^4(e^y)$. Note that the power of the sine function comes after the expression for the argument. Another example: `acos(exp(1)^(-1))` means $\arccos(e^{-1})$.
- (5) Logical expressions in Matlab, Octave, and IODE. Expressions like `x>=2` are treated as logical functions, and return a value of either 1 (true) or 0 (false). So `x>=2` is the step function that equals 1 if $x \geq 2$ and equals 0 otherwise. For example, logical functions help us create functions defined piecewise: The expression `(t^2)*(t<4)` means t^2 if $t < 4$ and 0 otherwise.