CAS CALCULATOR 'MATES10'

USER GUIDE

VERSION 10.0.34

1 CONTENTS

2 How to input data

2.1 Common inputs

By common inputs we refer to a mathematical expression as, for example: 2+2, (1+1/10)^10, (x-100)*(x+100) or sin(PI/2) where numbers are expressed in decimal base and trigonometric function's argument in radians. If the expression can be evaluated into a real or complex number, this will be the output.

If the variables' length is set to one character, the calculator will insert implicit operators in an expression such as 2x3-x2-1 converting to 2*x^3-x^2-1. Otherwise, if the variables length can be more than one character the calculator will interpret:

2*x3 – x2 -1 where x3 and x2 are two different variables.

If the default culture is set (en-US), numbers may be entered using a colon (,) as thousand separator and a dot (.) as decimal mark, for example: 1,234,567.89. Setting other culture, the thousand separator and decimal mark may be another.

2.2 Common errors

One common error is to employ the letter 'e' as a variable name. Letter 'e' is reserved for Napier's constant (also called Euler's number) 2.718… So, for the parser, the expression (a+e+f)^2 is the same as (a+2.718…+f)^2, were 'e' represents a number and not a variable. A solution would be to use another letter, or prefix with an underscore: (a+_e+f)^2.

2.3 Spaces

Blank spaces are ignored but not carriage return or tabulation characters.

2.4 Decimal, Hexadecimal, Octal and Binary Input

Hexadecimal, octal and/or binary numbers with the dot (.) can be entered by prefixing &h, &o or &b, respectively. When one of the following &h, &o, &b or &d followed by a number, respectively, in hexadecimal, octal, binary or decimal base is found in an expression, the prefix overrides the previous base: 10+&h0f+10 gives 41 at the output (decimal: 10+15+16=41) as result (not 35). To restore initial default decimal base &d should be prefixed: 10 + &h0f + &d10 = 35. So, in brief, the initial default base is decimal until a new base is found and, this last one prevails until a new base prefix overrides.

Entering &h0.8 will produce the decimal result 0.5 (= ½)

2.5 FUNCTIONS, VARIABLES AND CONSTANTS

Predefined functions are:

```
logtwo|logten|acosh|acoth|acsch|asech|asinh|atanh|floor|round|norm|conj|coth|csch|sech|
acos|acot|acsc|asec|asin|atan|cosh|sign|sinh|sqrt|tanh|abs|cos|cot|csc|exp|log|sec|sin|sqr|tan
|ln|re|im|%
```

logtwo(x) is equivalent to log(x)/log(2)

logten(x) is equivalent to log(x)/log(10)

Both log(x) and ln(x) are the Napierian logarithm of x

re(x) is the real part of x

im(x) gets the imaginary part of x

Predefined constants are:

```
e = 2.718281828459045
pi= 3.141592653589793
phi= 1.618033988749894
```

By default, only one character is allowed for variables (and custom functions). To change the default (&var0) in order to allow more than one character, input &var1

So, for a custom function 'fnc2(x, y)', the input

```
&var1 fnc2(3,2)
@fnc2(x,y)=x-y
```

outputs 1

2.5.1 Predefined functions

Trigonometric (sin, cos, …) functions' argument are expected to be expressed in radians. The default base is radians and may be changed prefixing &deg (for degrees) or &grad (for gradians) to the angles. To restore again radians, prefix &rad to the angle. Example:

for an input "sin(&deg 90) – cos(90) + sin(&grad 100) – cos(100) + sin(&rad PI/2) – cos(pi/2)" the result will be 3 (= 1 – 0 + 1 – 0 + 1 – 0)

Other functions for vectors or matrices are:

```
identity, echelon, cof, cross, dot, eigenvalues, egvl, eigenvectors, egv, transpose, trn, adj,
factorize, factors, trace, rank, roots, gcd, lcm, det, jordan, inverse, mod, jacobian,
partialfractions, lagrangianinterpolation, orthog, max, min
```

2.5.2 Custom functions

User may define custom functions by entering a new line and starting the line with an @ character. If there is more than one argument, arguments should be separated by a coma. For example, for the input:

```
f(3,2)
@f(x,y)=x-y
```

```
 output 1
```

A user function may define as image a value or a matrix.

The use of coma is reserved for custom functions; in all other functions or matrices, use semicolons to separate arguments or columns.

2.6 EQUATIONS AND SYSTEM OF EQUATIONS

The calculator tries to solve equations: x2-x+1=0, sin2(x)-0.5=0.2 or tan(x)=-2 are equations.

System of Equations should be entered separating one equation from another by a row delimiter, i.e., a carriage return character ('CR' or 'enter') or by a pipe ('|' or vertical bar) character. For example: entering the system x + y =2| x – y = 1 will give x = 3/2, y = 1/2 as output.

2.7 INTERPOLATION

2.7.1 Entering the points.

Given the points $(x_j,f(x_j))$, viz, (-2,1), (0,-1) and (2,1) the input could be

lagrangianinterpolation(-2;1|0;-1|2;1)

or

lagrangianinterpolation(
-2;1
0;1
2;1)

i.e., separating the coordinates by column delimiters and separating the points by row delimiters.

2.7.2 Entering interval limits, the polynomial degree and the function to approximate.

Given an interval [a, b], the desired polynomial degree 'n', and the function f(x) to approximate, substituting a, b, n and f(x) in lagrangianinterpolation(a; b; n; f(x)) by values, for example:

lagrangianinterpolation(-1;1;10; abs(x))

will result, at the output, in a polynomial of degree equal to 10, approximating the function abs(x), absolute value of x, at the interval [-1,1]. For this same example, a set of 11 points x_i, solutions of the Chebyshev Polynomial of degree 11, conform 10 subintervals at [-1,1]; then, abs(xi), 0<i<10, is calculated and finally the Lagrangian polynomial. If the 'detail' option is checked, the output will show the intermediate steps.

2.8 DERIVATIVES

Derivatives are prepended by a D: entering D(D(x^2*y)) will produce an output equal to 2; derivates respect the first variable present in the expression (x).

Entering Dy(x^2*y) will output x^2, the derivative respect 'y'.

2.9 MATRICES

2.9.1 Column delimiters

Characters tabulator 'tab' or semicolon (';') separate matrices' columns

2.9.2 Row delimiters

Carriage return ('CR' or 'enter') or pipe ('|' or vertical bar) characters separate rows.

3 FORMATTING THE OUTPUT

3.1 ROUNDING.

Modifier &dec configures the number of decimals. Maximum is 15 decimals.

So, input `&dec4 pi` will output `3.1416`

Engineering versus general notation.

Engineering notation, &eng1, outputs using exponents multiples of 3:

Input '&eng1 2^35' outputs `34.359738368e9`

While, '&eng0 2^35' outputs `3.4359738368e10`

3.2 FRACTIONS.

Fractions option (&fra0) will try to produce fractions in the output, although sometimes it is not possible due to the lack of precision.

3.3 DECIMAL, HEXADECIMAL, OCTAL AND BINARY OUTPUT

Decimal output is always carried out. Selecting options for other bases brings output in the selected bases. Outputs in hexadecimal, octal and binary base are prefixed by &h, &o and &b, respectively.

3.4 DETAILED INFO

The '&detail1' option, if available, will append intermediate steps to the output.

4 MODIFIERS

The list of modifiers is (also, you may set most in the ‘Options’ menu):

```
&dec decimals

&mod modulus

&mathml0|&mathml1 output as MathML

&var0|&var1 variable length

&irtnl0|&irtnl1 try irrationals

&eng0|&eng1 output in engineering notation

&rad|&deg|&grad angle base

&detail0|&detail1 try to detail

&fra0|&fra1 try to express in fractions

&h|&o|&b|&d hexadecimal, octal, binary, decimal base

i|j complex symbol
```