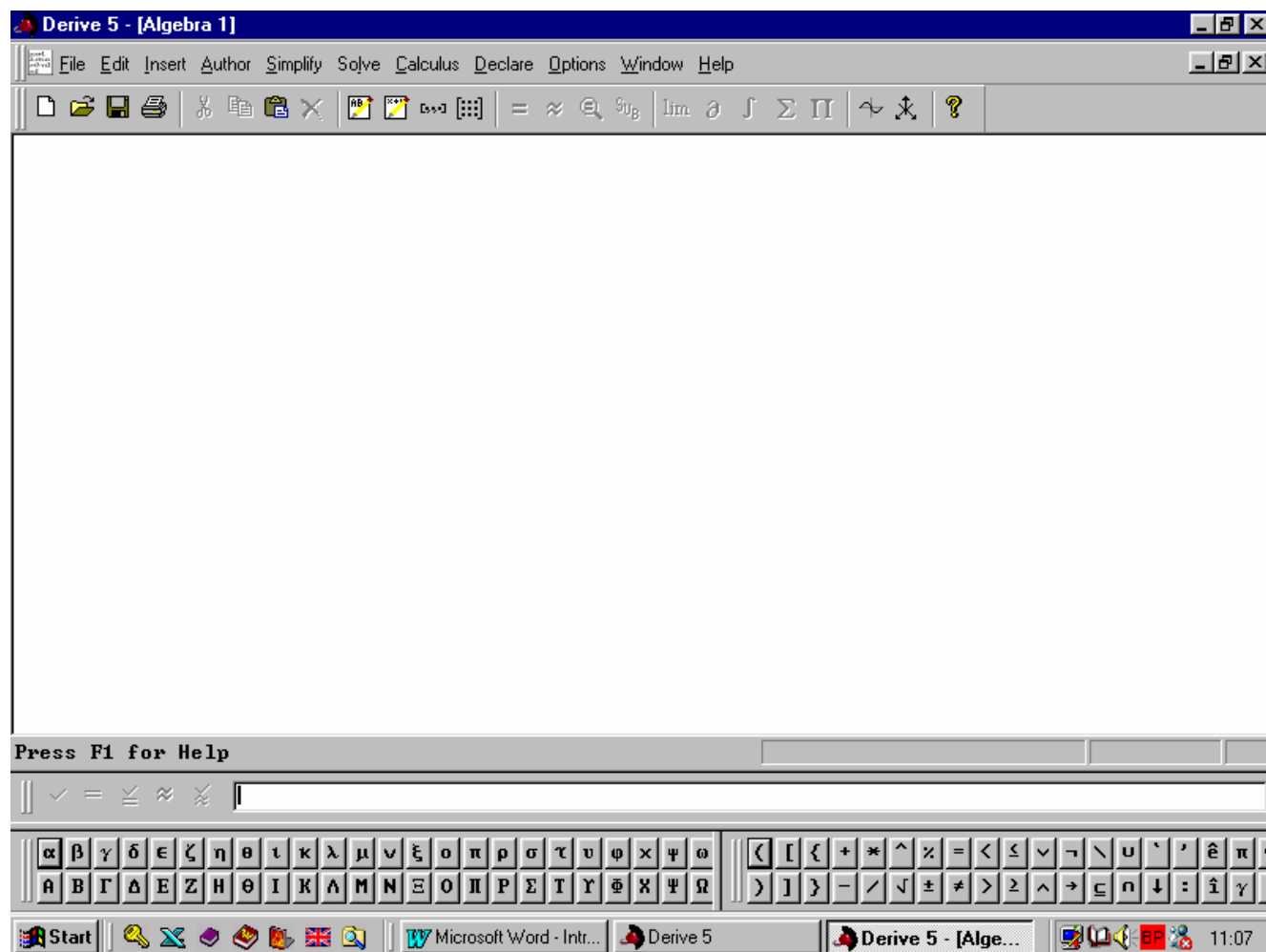


Introduction to DERIVE

The computer algebraic system DERIVE (CAS DERIVE) is often described as a “mathematical assistant”. It is a powerful and easy-to-use computer package for solving a range of mathematical problems. The aim of this introduction is to present some of the basic functions and commands in DERIVE.

1. The DERIVE window.

When you start DERIVE a window like this will appear:



The window of DERIVE is similar to other basic programs run under WINDOWS.

What you see is the so called *algebraic window*. It is used for writing and working with algebraic expressions, equations and formulas. In the lower part of the window there is a narrow, long field where inputs are made. We will call it *input field*. There are two groups of buttons under it. The left group consists of both capital and lower case Greek letters, and the right one contains the basic mathematical symbols.

DERIVE has both 2D and 3D graphic windows.

In the next few paragraphs you will find out how to enter and work with algebraic expressions, equations and how to draw graphics.

2. Entering expressions in DERIVE.

After starting DERIVE usually the marker is in the *input field*. If the marker is not there, then left click in the field using your mouse. You are now ready to enter expressions or equation in DERIVE.

I. Enter the expression $\frac{1}{4} - \frac{7}{12} + \frac{9}{17}$. To do this, in the *input field* you have to write $1/4 - 6/12 + 9/17$.

Press the **Enter** key on your keyboard.

The following will appear on the screen

#1:
$$\frac{1}{4} - \frac{7}{12} + \frac{9}{17}$$

Note 1:

When you are entering expressions in DERIVE you can use all the standard keys of the keyboard for editing: ←, →, **Home**, **End**, **Backspace**(←) and **Delete**.

II. Enter the expression 9^{27} : In the *input field*, write 9^27 . Press **Enter**.

The following will appear on the screen:

#2:
$$9^{27}$$

III. Enter the expression $\frac{x-4}{x^2-9x+20}$: Write $(x-4)/(x^2-9x+20)$. Press **Enter**.

The following will appear on the screen:

#3:
$$\frac{x-4}{x^2-9x+20}$$

IV. Now enter the expression $\frac{3}{x-5} - \frac{7-x}{x^2+1}$ on your own.

Note 2:

1. Pay attention to where and how you place the brackets. When entering expressions and equations you can only use the following type of brackets: (). Do not use square brackets: []. They are reserved for entering vectors and matrices.
2. After pressing **Enter** check whether the expression appearing on the screen looks like the one you have entered.
3. If the expression appearing on the screen is not the same as the expression that you have entered, then you need to **edit** it. In order to do this, you need to:
 - Double click the number of the row where the expression is located. In the *input field* a copy of this expression will appear.
 - Perform the necessary corrections and press **Enter**.
 - Go back to step 2.


V. Enter on your own the following expression: $\frac{\sqrt{d^2-f^2}}{d-f}$.


Note 3:

In order to enter $\sqrt{\quad}$, select one of the following two options:

Option I: Enter **sqrt** and then write in brackets the expression under the square root i.e.

Enter **sqrt**($d^2 - f^2$)/($d - f$) ↵.

Option II: In the field with mathematical symbols click on the button  and the sign for square root will appear in the input field. After that, write in brackets the expression under the square root i.e.

Enter  ($d^2 - f^2$)/($d - f$) ↵.

VI. When working using the scheme given in step 3 from note 2, edit the expression in such a way so as to get $\sqrt{\frac{d^2 - f^2}{d - f}}$.

3. Simplifying expressions in DERIVE.


We will now use DERIVE to simplify each of the expressions entered so far.

I. Simplify $\frac{1}{4} - \frac{7}{12} + \frac{9}{17}$. Highlight the expression $\frac{1}{4} - \frac{7}{12} + \frac{9}{17}$, by clicking the number of the row it is located in using the left mouse button. Select from the menu **Simplify**. After that, select **Basic**.

You will get the following result: $\frac{10}{51}$.

Note 4:

1. The default setting for DERIVE is such that it gives the result in the form of a fraction.
2. From now on when we want to specify that several operations are to be successively carried out, as in the case of simplifying $\frac{1}{4} - \frac{7}{12} + \frac{9}{17}$, this is facilitated in the following way: Highlight the expression $\frac{1}{4} - \frac{7}{12} + \frac{9}{17}$ > **Simplify** > **Basic**.

Enter the result in the form of a decimal number: Highlight the row in which the fraction is located > Press button .


Now we will demonstrate a different, faster method for simplifying expressions using button .

II. Highlight the expression 9^{27} > Press button .

You will get the following result:

#7:

58149737003040059690390169

III. Simplify on your own the expressions $\frac{x-4}{x^2-9x+20}$, $\frac{3}{x-5} - \frac{7-x}{x^2+1}$ and $\sqrt{\frac{d^2-f^2}{d-f}}$, by highlighting each of them and using the button . You should obtain respectively:

#8:

$$\frac{1}{x - 5}$$

#9:

$$\frac{2 \cdot (2 \cdot x^2 - 6 \cdot x + 19)}{(x - 5) \cdot (x^2 + 1)}$$

#10:

$$\sqrt{(d + f)}$$

Delete all expressions entered so far by *highlighting them one by one and pressing Delete for each of them.*

3. Factorization.

I. Factorize the expression $2x^3 - 17x^2 + 27x + 18$: *Enter the expression > Press **Simplify > Factor > Factor.***

You will get the following result:

#4:

$$(x - 3) \cdot (x - 6) \cdot (2 \cdot x + 1)$$

4. Expanding brackets.

I. Expand the brackets in the expression $(3x - 5)(2x - 1)(4x - 3)$: *Enter the expression > Press **Simplify > Expand > Expand.*** You will get:

#5:

$$24 \cdot x^3 - 70 \cdot x^2 + 59 \cdot x - 15$$

II. Expand the brackets in the expression $(x + 5)^{10}$.

5. Entering and solving equations in DERIVE.

I. Solve the equation $x^2 + 5x + 6 = 0$: *Enter the expression $x^2 + 5x + 6$ > press **Solve > Expression > Solve.*** You will get the following result:

#8:

$$x = -3 \vee x = -2$$

Note 5:

In order to solve any equation which is in the form $f(x) = 0$, it is not necessary to write “= 0” at the end, i.e. it is only necessary to *enter the expression $f(x)$* and to *press **Solve > Expression > Solve.***

II. Solve the equation $2x^3 - 17x^2 + 27x + 18 = 0$. Since in step 4 we have already entered the expression $2x^3 - 17x^2 + 27x + 18$, it is not necessary to enter it again. Perform the following operations:

- *Highlight the row which contains the expression $2x^3 - 17x^2 + 27x + 18$*
- *If the input field is not empty, then empty it by doing the following: Click in the input field using the right mouse button and highlight the expression which is there > Delete it by pressing **Delete.***
- *Press **F3** and the desired expression $2x^3 - 17x^2 + 27x + 18$ will appear in the input field.*
- *Press **Enter.** We're now ready to solve the equation.*
- *Solve it using the instructions given in point I.*

6. Transposition of formulas.

I. Enter the formula $p = \frac{16u}{u-a}$. Here the variable p is expressed using the variables u and a . If we want to express the variable a using u and p , then it is necessary to do the following: *Enter the expression $p = \frac{16u}{u-a}$ > Press **Solve** > **Expression** > **In Solution Variables** highlight the variable a > **Solve**.*

You will get the following result:

#11:
$$a = u - \frac{16 \cdot u}{p}$$

II. Now transpose the given formula so that u is expressed using a and p .

7. Substitution.

Enter the formula $a = \rho(1+\theta)^n$. Substitute the variables on the right with the following values

$\rho = 10, \theta = 1/3, n = 5$. To do this: *Enter the formula > press button *.

In the window which appears, do the following:

- Highlight the variable n > click in the field **New Value:** and enter 5;
- Highlight the variable ρ > click in the field **New Value:** and enter 10;
- Highlight the variable θ > click in the field **New Value:** and enter 1/3.


You will get the following result:

#15:
$$a = \frac{10240}{243}$$


Now write down the result in the form of a decimal number.

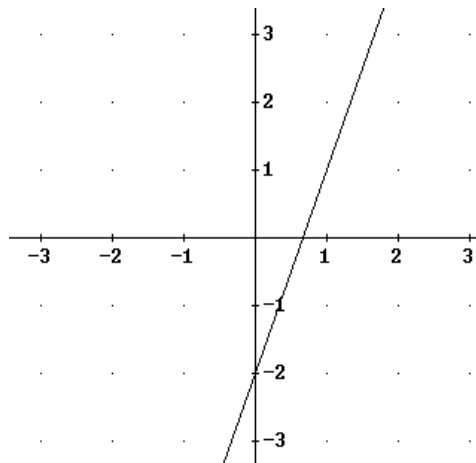
Delete everything entered so far.

8. Plotting graphs.

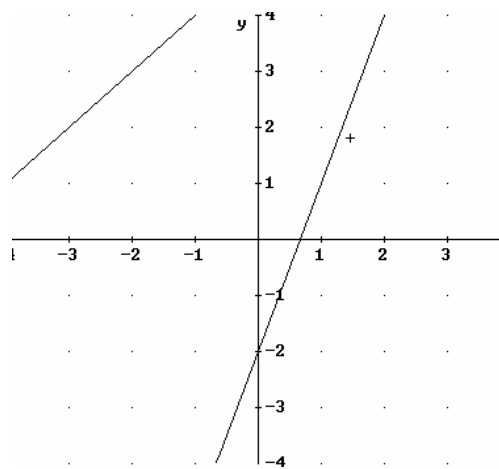
I. Plot the graph of the function $y = 3x - 2$: *Enter $3x - 2$ > Press button *.

As a result of these operations a new window will appear – **a graphical window**, which will cover the algebraic window which we have been working with until now. In the graphical window you can see a coordinate system.


Press again button  and the plot of $y = 3x - 2$ will be displayed on the coordinate system given, as shown below.



II. Plot the graph of the function $y = 5 + x$ in the same coordinate system. You have to get the following result:

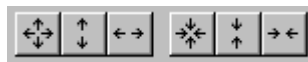


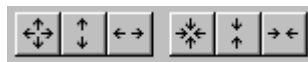

Note 6:

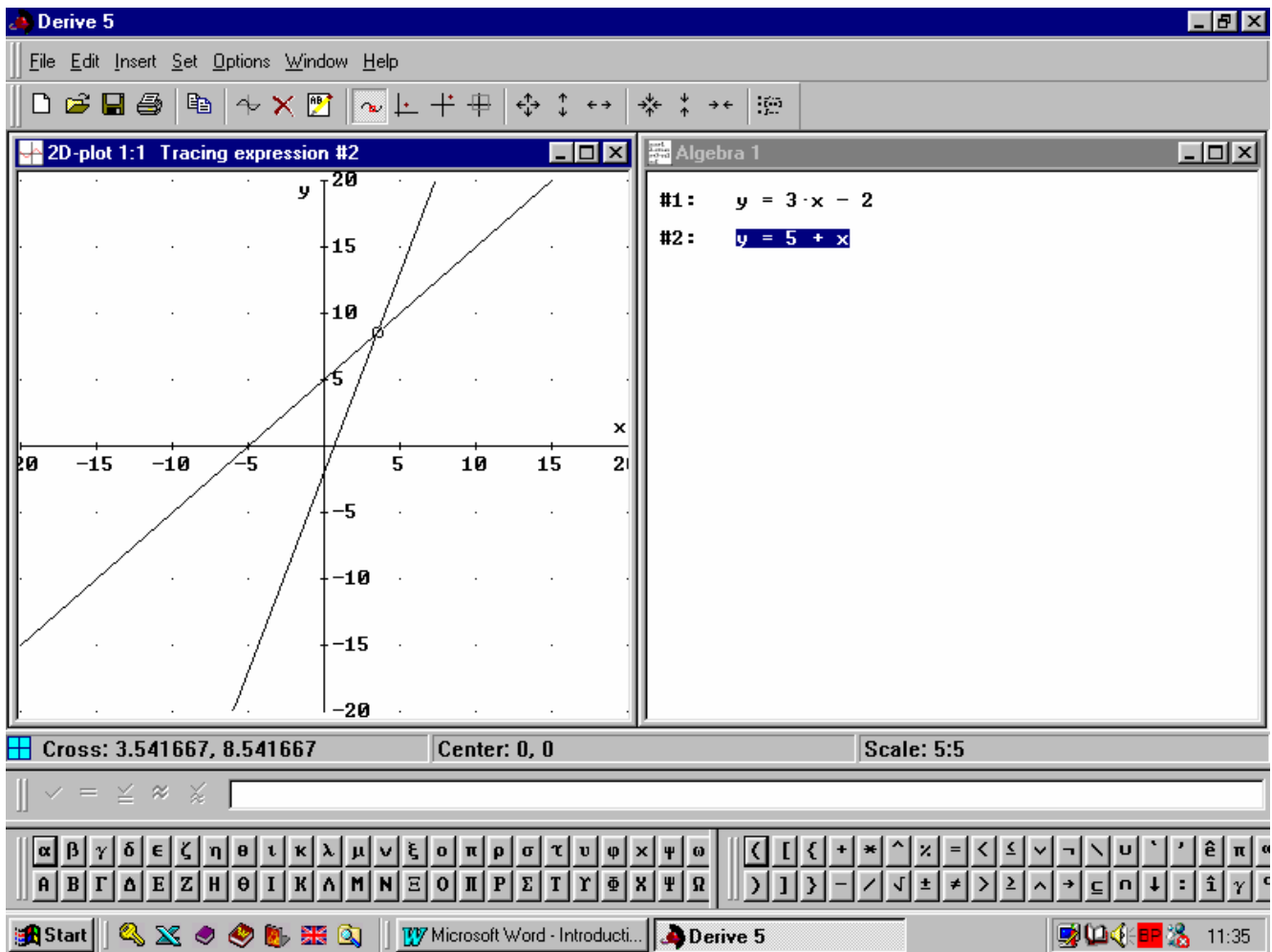
1. In order to go back to the algebraic window, use button .
2. If you want to see the algebraic and graphical windows at the same time, do the following: *From the menu select **Window > Tile vertically**.*
3. In order to switch between windows you just have to *click in the window* in which you would like to work at any time.

III. Find the coordinates of the points of intersection of the two graphics.

First do this graphically:

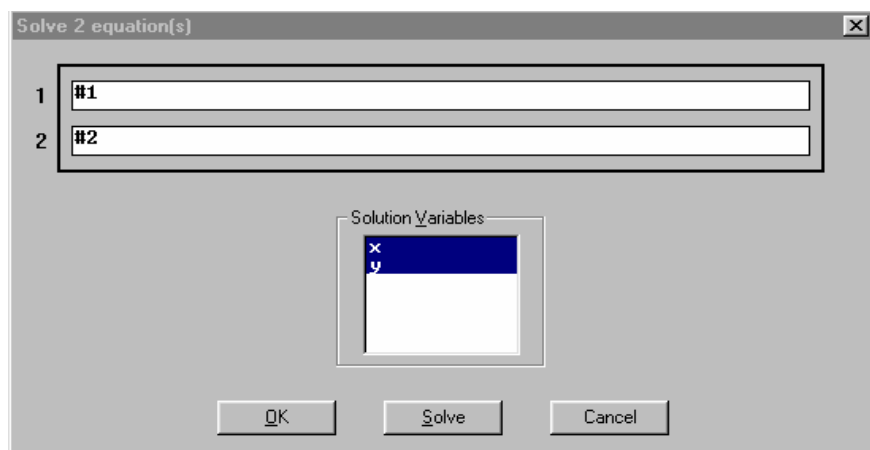


1. In the graphical window use buttons  in order to see the point of intersection of the two lines.
2. Click on button . In one of the graphs a small circle will appear. Using keyboard keys \downarrow and \uparrow you can transfer this circle from one graph to the other. Using keys \leftarrow , \rightarrow you can move the circle within the graphic where it is located.
3. Move the circle to the point of intersection of the two lines. In the left corner under the graphic you can will see the coordinates of this point: **Cross: 3.541667, 8.541667**



Now find the coordinates of the point of intersection analytically, by solving the system of equations for the two lines:

1. Switch to the algebraic window.
2. From the menu choose **Solve > System**.
3. In the small window which appears you have to indicate the number of the equations in the system which you are going to solve: In the **Number:** write *2* > **Ok**.
4. A new window will appear, in which you have to indicate the two equations. Since these equations have already been entered you will not need to enter them again. All you need to do is *to enter the number of the rows in which they are located*, in this case #1 and #2, as shown below. Press **Solve**.



5. You will get the following result :

#4:
$$\left[\begin{array}{l} x = \frac{7}{2} \wedge y = \frac{17}{2} \end{array} \right]$$

Write the result using decimal numbers.

II. Draw the parabola $y = x^2$ and the line $y = 2x + 24$. Find the coordinates of their points of intersection, first graphically and then analytically.

Close the graphical window. Empty the algebraic one by highlighting all the expressions and press **Delete**. Maximize it by double clicking the blue field on top.

9. Differentiation.

I. Find the derivative of the function $f(x) = x^3 + 3x^2 + 2$: Enter $x^3 + 3x^2 + 2$ > Press $\frac{d}{dx}$ > **Variable: x** > **Order: 1** > **Simplify.**

You will get the following:

#2: $\frac{d}{dx} (x^3 + 3 \cdot x^2 + 2)$

#3: $3 \cdot x^2 + 6 \cdot x$

II. Find the derivative of the function $f(x) = x^3 \sin x$.

10. Integration.

I. Calculate an indefinite integral from the function $f(x) = 3x^2 + 6x$: Click the number of the row in which the expression is located $3x^2 + 6x$ > Press \int > **Variable: x** > Select an indefinite integral **Indefinite** > **Simplify.**

You will get the following:

#4: $\int (3 \cdot x^2 + 6 \cdot x) dx$

#5: $x^3 + 3 \cdot x^2$

Repeat the procedure but this time enter **c** in the field **Constant:** in the window which appears after you press \int . you will get the following:

#6: $\text{INT}(3 \cdot x^2 + 6 \cdot x, x, c)$

#7: $x^3 + 3 \cdot x^2 + c$

II. Calculate the indefinite integral for the function $f(x) = x^3 \sin x$.

11. Entering text in the DERIVE window.

In order to enter text in DERIVE, do the following:

1. If the algebraic window is empty, then *select from the menu **Insert** > **Text object** > Click in the rectangle which appears and enter your text.*
2. If the algebraic window is not empty, then highlight the row after which you wish to enter the text and repeat step 1.
3. If you wish to write in Bulgarian, then *even before you click **Insert**, select from the menu **Options** > **Display** > **Font of New Text Objects** > *Select the font you want (**Font**) > Switch to Cyrillic > Perform respectively step 1 or step 2, depending on the situation at hand.**

12. Some useful keys:

Key	Usage
F3	Copies a highlighted expression from the algebraic window to the input field.
F4	The same as F3, but the expression in the input field will be put in brackets.
F1	Hotkey for calling up the Help menu.
Ctrl E	Hotkeys for entering the exponential e .
Ctrl P	Hotkeys for entering π .
Ctrl Q	Hotkeys for entering square root.
Ctrl I	Hotkeys for entering the imaginary unit i .

13. Some useful built in functions of DERIVE.

Exponential function:

EXP(z) – the exponent from the expression z , i.e. e^z (When you are entering e^z , instead of EXP(z), you can enter the expression $|^z$).

Logarithm functions:

LN(z) – Natural logarithm from the expression z ($z > 0$).

LOG(z) – Natural logarithm from the expression z ($z > 0$).

LOG(z , 10) – Decimal logarithm from the expression z ($z > 0$).

LOG(z , a) – Logarithm from the expression z ($z > 0$) with base a .

Trigonometric functions:

SIN(z) – $\sin z$

COS(z) – $\cos z$

TAN(z) – $\operatorname{tg} z$

COT(z) – $\operatorname{cotg} z$

Inverse trigonometric functions:

ASIN(z) – $\arcsin z$

ACOS(z) – $\arccos z$

ATAN(z) – $\operatorname{arctg} z$

ACOT(z) – $\operatorname{arccotg} z$

Note 8: It isn't necessary for the names of the functions to be written in capital letters.

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