Application of Information Technology and Mathcad, Maple - Computer Mathematics Systems in the Process of Teaching Mathematics in Education

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This article is devoted to the use of information technology and **Mathcad, Maple -** Computer Mathematics in education.

The use of information technology is one of the new forms of organizing the educational process. This is the implementation of a particular curriculum, focused mainly on independent work of students. The transition to an information society opens up new opportunities for modernizing educational content and teaching methods. The computer becomes a powerful tool for structuring and systematizing mathematical knowledge and skills, for shaping the worldview and developing the student's intellect.

When systematically using a computer in teaching mathematics, the following basic principles must be taken into account. To obtain the expected result, the computer must be used constantly in the educational process. The teacher must be fluent in computer use, apply flexible methods of using teaching materials in various types of educational activities, aimed at activating the student [1].

In the last fifteen years, a new fundamental scientific direction - computer mathematics - has emerged and developed rapidly, which originated at the intersection of mathematics and computer science. Following this, based on the achievements of computer mathematics, the latest software systems for symbolic mathematics or computer algebra were developed. Among them, the most famous systems are Mathcad for Windows and Maple, etc.

Although many (and even most) mathematical problems can be solved using the SCM computer mathematics system without programming, this does not mean abandoning programming altogether. On the contrary, all SCMs, in particular Mathcad for Windows and Maple, have a fairly developed programming language containing standard procedural programming tools, such as control structures, loops, input/output operators, etc.

Recently, such languages have included tools for visually oriented user interface programming in Maple, these tools are called maplets. There is one very important circumstance in the modern implementation of these tools - many mapplets provide step-by-step solutions to mathematical problems with a demonstration of intermediate calculation results. This is exactly what was required from SCM in education for a long time and what they did not provide. Now such problem solving has become possible and significantly increases the importance of Maple systems in education and mathematics.

SCMs are widely used for scientific calculations, including Internet and mobile computing. But the role of systems is especially great

computer mathematics in education - they become not only a convenient tool for performing a huge number of educational calculations, but also a means of providing students, and often teachers, with knowledge in the field of mathematics, physics and other sciences that use mathematical methods. It is difficult to overestimate the role in the preparation of high-quality electronic lessons and training courses.

Using Mathcad to solve problems in elementary mathematics In Mathcad you can perform the following symbolic transformations of algebraic expressions:

simplify (simplify) – perform arithmetic operations, bring similar ones, reduce fractions, use basic identities to simplify (abbreviated multiplication formulas, trigonometric identities, etc.);

expand (expand) – open the brackets, multiply and bring similar ones;

factor (factorize) – represent, if possible, the expression as a product of simple factors;

substitute (substitute) – replace a letter or expression in an algebraic expression with another expression;

convert to partial fraction – decompose a rational fraction into simple fractions.

Example 1. Simplify the expression

$$\left(1 + \frac{2}{3\,x - 1}\right)\left(1 - \frac{9\,x - 9\,x^2}{3\,x + 1}\right) + 1.$$

$$\left(1 + \frac{2}{3 \cdot x - 1}\right) \cdot \left(1 - \frac{9 \cdot x - 9 \cdot x^2}{3 \cdot x + 1}\right) + 1 \ \text{simplify} \ \rightarrow 3 \cdot x$$

Example 2. Expand the brackets and give similar ones in the expression

$$x\,(z + 1)^2 - 2\,z\,(x + z)$$

$$x \cdot (z + 1)^2 - 2 \cdot z \cdot (x + z) \ \text{expand} \ \rightarrow x + x \cdot z^2 - 2 \cdot z^2$$

Example 3. Factorize the expression

$$a^2\,b + a\,b^2 + 2\,abc + b^2\,c + a^2\,c + a\,c^2 + b\,c^2$$

$$a^2 \cdot b + a \cdot b^2 + 2 \cdot a \cdot b \cdot c + b^2 c + a^2 \cdot c + a \cdot c^2 + b \cdot c^2 \ \text{factor} \ \rightarrow (b + c) \cdot (a + c) \cdot (a + b)$$

Example 4. Decompose a rational fraction into the simplest fractions

$$\frac{x^2 - 3\,x + 7}{(x - 1)^2\,(x^2 + x + 1)}$$

$$\frac{x^2 - 3 \cdot x + 7}{(x - 1)^2 \cdot (x^2 + x + 1)} \ \text{parfrac} \ \rightarrow \frac{2 \cdot x + \frac{10}{3}}{x^2 + x + 1} - \frac{2}{x - 1} + \frac{5}{3 \cdot (x - 1)^2}$$

Using Mathcad to solve nonlinear algebraic equations

The built-in function for solving equations has the form:

Solve(equation, variable);

Example. Solve an algebraic equation:

$$\frac{X^2 + 1}{x - 4} - \frac{x^2 - 1}{x + 3} = 23$$

$$\frac{x^2+1}{x-4} - \frac{x^2-1}{x+3} - 23 \text{ solve} \rightarrow \begin{pmatrix} -\dfrac{55}{16} \\ 5 \end{pmatrix}$$

Example. Solve the equation with the parameters:

$$x^2 - \frac{2\,(m^2+n^2)\,x}{m^2-n^2} + 1 = 0$$

$$x^2 - \frac{2\cdot(m^2+n^2)\cdot x}{m^2-n^2} + 1 \text{ solve},x \rightarrow \begin{pmatrix} \dfrac{m-n}{m+n} \\ \dfrac{m+n}{m-n} \end{pmatrix}$$
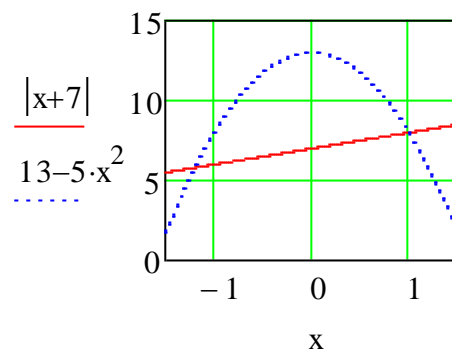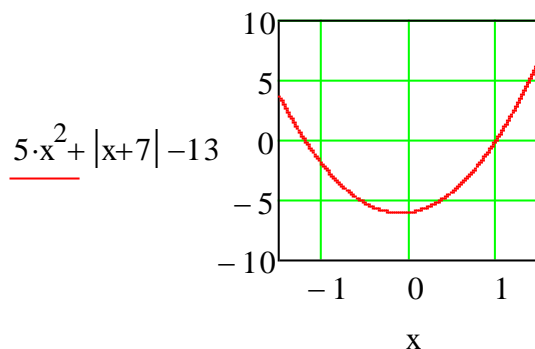
Example. Solve the equation with the modulus:

$$5\,x^2 + |x+7| - 13 = 0$$

$$5\cdot x^2 + \text{abs}(x+7) - 13 \text{ solve},\boxed{x} \rightarrow$$

Решение не было найдено.

This equation can be solved in Maple or graphically:

or using the Given-Find block:

$$x := 0 \quad \text{Given} \quad 5\cdot x^2 + |x+7| - 13 = 0 \quad \text{Find}(x) = 1$$

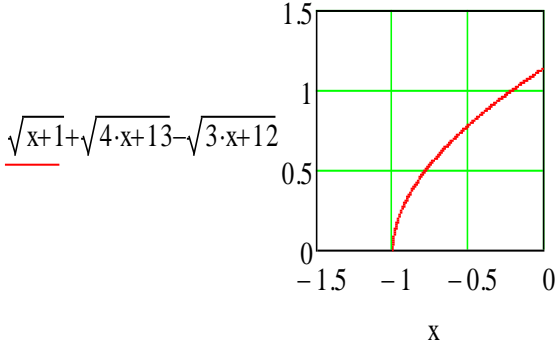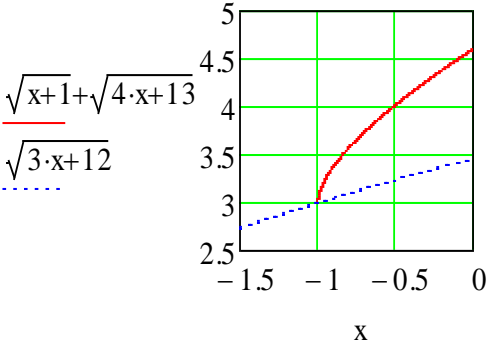$$x := -1 \quad \text{Given} \quad 5\cdot x^2 + |x+7| - 13 = 0 \quad \text{Find}(x) = -1.2$$

Example. Solve an irrational equation:

$$\sqrt{x+1} + \sqrt{4\,x+13} = \sqrt{3\,x+12}$$

$$\sqrt{x + 1} + \sqrt{4 \cdot x + 13} = \sqrt{3 \cdot x + 12} \text{ solve}, \underline{x} \rightarrow$$

This equation can be solved in Maple or graphically:

or using the Given-Find block:

$$x := 0 \quad \text{Given} \quad \sqrt{x + 1} + \sqrt{4 \cdot x + 13} = \sqrt{3 \cdot x + 12} \quad \text{Find}(x) = -1$$
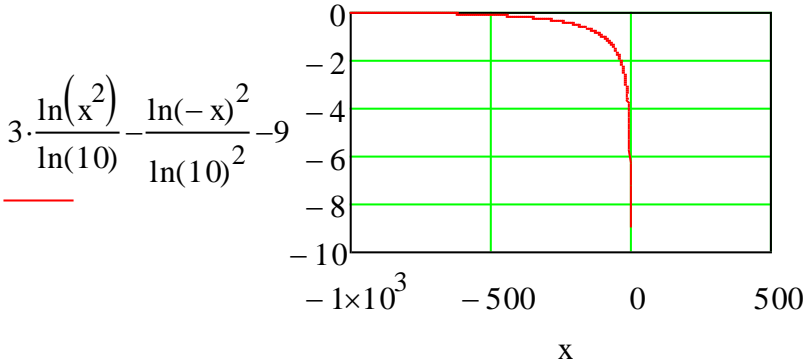
Example. Solve the logarithmic equation:

$$3 \frac{\ln(x^2)}{\ln(10)} - \frac{\ln(-x)^2}{\ln(10)^2} = 9$$

$$3 \cdot \frac{\ln(x^2)}{\ln(10)} - \frac{\ln(-x)^2}{\ln(10)^2} = 9 \text{ solve}, \underline{x} \rightarrow$$

This equation can be solved in Maple or graphically:

or using the Given-Find block:

$$x := -1$$

Given $3 \cdot \dfrac{\ln\left(x^2\right)}{\ln(10)} - \left(\dfrac{\ln(-x)}{\ln(10)}\right)^2 = 9$ $\text{Find}(x) = -1000$

Using Maple to solve nonlinear algebraic equations

The built-in function for solving equations has the form:

Solve (equation, variable);

Example. Solve an algebraic equation:

$$\frac{X^2 + 1}{x - 4} - \frac{x^2 - 1}{x + 3} = 23$$

Decision. The specified equation is entered and the correctness is checked:

> **(X^2+1)/(x-4)-(x^2-1)/(x+3)=23;**

$$\frac{X^2 + 1}{x - 4} - \frac{x^2 - 1}{x + 3} = 23$$

The equation was entered correctly. Finding the roots:

> **solve(%);**

$$\frac{-55}{16}, 5$$

A compact solution to the same equation:

> **solve((x^2+1)/(x-4)-(x^2-1)/(x+3)=23);**

$$\frac{-55}{16}, 5$$

Example. Solve the equation with the parameters:

$$x^2 - \frac{2\left(m^2 + n^2\right)x}{m^2 - n^2} + 1 = 0$$

Decision.

> **solve(x^2-2*(m^2+n^2)/(m^2-n^2)*x+1=0,x);**

$$-\frac{m + n}{-m + n}, -\frac{-m + n}{m + n}$$

Example. Solve the equation with the modulus: $5\,x^2 + |x + 7| - 13 = 0$

Decision.

> **solve(5*x^2+abs(x+7)-13=0);**

$$1, \frac{-6}{5}$$

Let's make a check:

> **subs(x=1,5*x^2+abs(x+7)-13=0);**

$$-8 + |8| = 0$$

> **subs(x=-6/5,5*x^2+abs(x+7)-13);**

$$-\frac{29}{5} + \left|\frac{29}{5}\right|$$

Example. Solve an irrational equation:

$$\sqrt{x+1} + \sqrt{4\,x+13} = \sqrt{3\,x+12}$$

Decision.

> **solve(sqrt(x+1)+sqrt(4*x+13)=sqrt(3*x+12));**

$$-1$$

Let's make a check:

> **subs(x=-1,sqrt(x+1)+sqrt(4*x+13)=sqrt(3*x+12));**

$$\sqrt{9} = \sqrt{9}$$

Example. Solve the logarithmic equation:

$$3\,\frac{\ln(x^2)}{\ln(10)} - \frac{\ln(-x)^2}{\ln(10)^2} = 9$$

Decision.

> **solve(3*log10(x^2)-(log10(-x))^2=9);**

$$-1000, -1000$$

Let's make a check:

> **subs(x=-1000,(3*log10(x^2)-(log10(-x))^2=9));**

$$3\,\frac{\ln(1000000)}{\ln(10)} - \frac{\ln(1000)^2}{\ln(10)^2} = 9$$

Similarly, systems of equations are solved through solve, only equations, like unknowns, are entered as sets – in parentheses.

In conclusion, it can be noted that the use of information technologies and Maple computer mathematics systems in education and mathematics significantly increases the development of educational materials.

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