# ENGLISH VERSION: THE USE OF MAPLE MATHEMATICAL SOFTWARE IN TEACHING MEDICAL AND BIOLOGICAL PHYSICS*

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*Computerization of training becomes an integral part of the educational process. The development of technologies, mobile devices necessitates the improvement and updating of training courses. The use of software in the learning process is widespread, which requires from a modern student to master the mathematical apparatus, to have knowledge of the basics of programming and the ability to work at the level of a confident user with a variety of software tools and applications. Particularly relevant is the need for the use of computer technologies during the study of topics for self-directed study. The introduction of information technologies will enrich the content and diversify the ways of mastering new topics, stimulating students for self-education and self-development. The article is devoted to application of the software package of applied mathematics Maple during the educational process of students of higher medical establishments.*

**Key words**: self-directed work, medical and biological physics, medical students, *Maple*.

The problem of using modern computer technology (CT) in the educational process is quite relevant nowadays. Questions concerning the use of modern information and communication technologies (ICTs) in the educational process have been thoroughly considered in the studies of V. Mykhalevych and Y. Krupskyi [6, 7], M. Zhaldak [15], V. Klochko [8], O. Spivakovskyi [9], Yu. Trius [10] and others. Researchers also describe the use of electronic textbooks, multimedia presentations [13], multimedia images, clinical cases, etc. [14, 13]. Particular attention of researchers is attracted to the question of using ICT in teaching the mathematical subjects. It was found that the most frequently studied subjects are the software products MathLab, Maple, Mathematica, STATISTICA [5].

The aim of the article is to analyze and highlight the main advantages and problems arising from the use of Maple system of computer mathematics in the educational process of medical students.

The curriculum of the subject "Medical and Biological Physics" involves the self-directed study of the content module "Fundamentals of Higher Mathematics and Biological Physics" (38 hours) by students of medical and dental faculties. The final control of students' knowledge often reveals unsatisfactory results in terms of topics, covered by self-directed study. The academic performance of completed self-directed tasks, as a rule, is not assessed above the satisfactory level [2].

The use of software in teaching medical and biological physics for medical students, in particular the computer-based mathematics software, is extremely important, as their study and use will facilitate the following processes:

- deepening the students' knowledge in higher mathematics, computer science;
- expanding the skills of solving tasks in higher mathematics of a diverse nature;
- formation of skills in using modern mathematical packages in the process of studying medical and biological subjects, as well as for future professional activities.

The study of medical and biological physics in higher medical schools should be applied in a way that will enable students to understand the need to study the subject as a foundation for most of special disciplines. Using the Maple package for solving applied problems in higher mathematics provides an increase in the level of motivation both for studying the discipline, and for the use of special software at the appropriate level and rapid problem solving. The most effective, in our opinion, is the use of the version of Maple 11, since it enables the solving of various tasks of mathematical analysis (boundary calculation, differentiation and integration of functions); solving differential equations and equations in partial derivatives. The need for the transition from manual data entry for calculation to work in the environment of computer mathematics system is determined directly by the teacher. The main task of this transition is the automation of routine operations [11].

Let us consider the following example:

Find $y'$, if $y = \sqrt[5]{\sin x}\ tg^2 x \sqrt[4]{\cos x}$ (1);

Since the function is a product of several factors, then before the differentiation it is necessary to carry out the logarithmation:

$$\ln y = \ln\left(\sqrt[5]{\sin x}\, tg^2 x \sqrt[4]{\cos x}\right) \implies \ln y = \frac{1}{5}\ln\sin x + 2\ln tg\, x + \frac{1}{4}\ln\cos x \implies$$

$$\ln y = \frac{1}{5}\ln\sin x + 2\ln\sin x - 2\ln\cos x \implies \ln y = \frac{11}{5}\ln\sin x - \frac{7}{4}\ln\cos x \quad (2)$$

After differentiating both parts of equality, we obtain:

$$(\ln y)' = \left(\frac{11}{5}\ln\sin x - \frac{7}{4}\ln\cos x\right) \implies \frac{1}{y}y' = \frac{11}{5}\frac{1}{\sin x}(\cos x) - \frac{7}{4}\frac{1}{\cos x}(-\sin x) \implies$$

$$y' = \sqrt[5]{\sin x}\ tg^2 x \sqrt[4]{\cos x}\left(\frac{11}{5}\cot x + \frac{7}{4}tg\, x\right) \quad (3)$$

Lengthy mathematical calculations in the example given above can be greatly simplified using the built-in

menu commands in the sequence: Tools → Tutors → Differential Equations. The result of calculations is immediately displayed on the screen, while there is a possibility of intermediate results, which will provide an understanding of the essence of the mathematical operations performed by students.

Using the Maple system can sometimes be limited to intermediate calculations, when full automation of the process is not permissible. Hence, the command "simplify" allows you to streamline the complex expression, "normal" − reduces the expression to a common denominator and performs reduction of a fraction, "solve" − outputs the result of the entered equation.

Here is an example. Solve the equation:

$$x^4 - 13x^2 + 36 = 0. \tag{4}$$

To solve the equation, you need to replace the variable by putting $x^2 = t$. (5)

We get $t^2 - 13t + 36 = 0$. (6)

$$\begin{Bmatrix} t_1 + t_2 = -13 \\ t_1 * t_2 = 36 \end{Bmatrix} \Rightarrow \begin{Bmatrix} t = 4 \\ t = 9 \end{Bmatrix} \tag{7}$$

Returning to the substitution, we get the result:

$$\begin{bmatrix} x^2 = 4 \\ x^2 = 9 \end{bmatrix} \Rightarrow \begin{matrix} x = \pm 2 \\ x = \pm 3 \end{matrix}. \tag{8}$$

The result of calculations in the Maple system is shown below.

$$> solve\ ((x^4 - 13 * x^2 + 36 = 0\}, \{x\};$$

$$\{x = -2\}, \{x = 2\}, \{x = -3\}, \{x = 3\}. \tag{9}$$

For algebraic transformations, the Maple system is also equipped with a set of functions, in particular: "expand" − to open brackets, "factor" − to expand into multipliers, "collect" − to build similar members.

In our opinion, the function "subs" (checking of correctness of solutions of equations) is particularly useful during practical classes and, especially, during the performance of self-directed work. A powerful system tool is the "plot" command, which allows you to build graphs of functions of one variable. In addition, the system is equipped with a set of commands for building three-dimensional images and animations. These functions largely become useful to the teacher in preparation for practical classes. With the help of the package, the teacher can not only show the possibility of a quick solution to the problem, but also graphically illustrate its solution.

It should be noted that the system of computer mathematics cannot replace the presence and influence of the teacher in the classroom, and, first of all, involves the competent use of tools at the stage when the student mastered the skills and abilities for solving the tasks of the corresponding section of higher mathematics at an appropriate level. The proper use of this package in the educational process ensures an increase in the level of mutual convergence of medical and biological subjects, and education in general.

The advantages of the system are the speed of the calculation process, the self-directed performance of the tasks by students, the acquisition of skills in using computers and modern software. The disadvantages should also be highlighted: namely, the impossibility of controlling the actions of students by the teacher when solving the task; checking only the final answer without a detailed description of the errors. Using the Maple program allows students to study certain topics independently, and the learning process becomes easier and more interesting, deprived of psychological barriers.

## Conclusions

The rapid development of computer technologies, their use in the educational process changes the approaches to teaching and requires from students mastering the modern software. In the setting of a higher medical institution, computer technologies are widely used, which is not limited to studying medical informatics. Software, including systems of computer mathematics, can be effectively used in the study of medical and biological physics during the first year of study. It is advisable to use the Maple package for solving problems of higher mathematics of the content module "Fundamentals of Higher Mathematics and Biological Physics", both in preparation for practical classes and in self-directed work on topics. The purpose of using Maple is to simplify the lengthy calculations, to clarify the solution of tasks, to overcome the psychological barrier in studying the complex topics, which significantly differ from the school course of mathematics and physics in terms of content.

Using the standard commands of the Maple system of computer mathematics, one can obtain the final answer when solving a wide range of mathematical problems. The Maple system is equipped with a powerful algebraic toolkit, which can be used to solve a particular task and its individual parts.

An important component of the system during the study of medical and biological physics is a built-in complex of commands for constructing two-, three-dimensional graphs of functions and animations. The need to use the program is also due to an increase in the proportion of topics covered by the self-directed study.

The use of software in the study of the subject must be competent, that is, used at the stage when the student has sufficiently mastered the methods of solving the tasks.

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