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Universidad del Zulia
Facultad Experimental de Ciencias
Departamento de Ciencias Humanas
Maracaibo - Venezuela

Using Systems Of Computer Mathematics Maple In The Course Training As Equations

**Burkhan Kalimbetov¹, Dinmukhambet Sapakov¹,
Raskul Ibragimov²**

¹A. Yasawi International kazakh-turkish university, 161200, B.Sattarkhanov
29, Turkestan, Kazakhstan

E-mail: bkalimbetov@mail.ru, sapakov1986@mail.ru

²South Kazakhstan State Pedagogical University, 160012, A.Baitursynov 13,
Shymkent, Kazakhstan

E-mail: raskul1953@mail.ru

Abstract

The article presents the methodological approaches to the study of the continuity of functions, knowledge of which has a significant impact on both the mathematical and methodological training of future specialists. The formation of intuitive visual representations is a primary task for mastering the notion of continuity. As a result, Assessment of the level of mastering of concepts should be conducted, basically, not by the ability to reproduce the definitions of the continuity of a function at a point, but at the level of identification. In conclusion, we note that systems of computer mathematics should be used as ICT tools in training.

Keywords: Information, Communication Technologies,
Computer Mathematics.

Uso de sistemas de computación matemática Maple en el curso de formación como ecuaciones integradas

Resumen

El artículo presenta los enfoques metodológicos para el estudio de la continuidad de las funciones, cuyo conocimiento tiene un impacto significativo en la formación matemática y metodológica de los futuros especialistas. La formación de representaciones visuales intuitivas es una tarea primordial para dominar la noción de continuidad. Como resultado, la evaluación del nivel de dominio de los conceptos debe realizarse, básicamente, no por la capacidad de reproducir las definiciones de la continuidad de una función en un punto, sino a nivel de identificación. En conclusión, observamos que el SCM debe usarse como herramientas de TIC en la capacitación.

Palabras clave: Información, Tecnologías de la Comunicación, Matemática Computacional.

1. INTRODUCTION

This article discusses some possibilities of the course of differential equations that can be realized thanks to the computer mathematics systems. The main attention is paid to the graphical methods of solving and graphical interpretation of the solution of the differential equation. A characteristic feature of the present period of the development of society is its informatization. In all areas of human activity, the importance of information processes increases, the need for information and in the means for its production, processing, storage, transmission and the usage is increased, which causes the emergence of new information and communication technologies

(ICT). In its turn, ICT plays an important role in the scientific, technical, socio-economic development of the world community. It significantly influences the accelerated development of science, technology and various branches of the economy, plays a significant role in the processes of upbringing and education, cultural communication between people, as well as in other social fields.

The goals and objectives of informatization of higher education are predetermined by the new demands of the labor market, the demands of the world community for specialists, and include not only the acquisition of basic knowledge, but also the skills to use the information resources efficiently, constantly master new knowledge, skills and skills in the field of information and telecommunication technologies. Thus, one of the key issues in the concept of higher education is the training of a competitive professional, who must be able to effectively use ICT in his/her professional activities, that is, to possess a high degree of ICT competence in their own field of activity. The issues, related to the informatization of education were considered by Talyzina(1983) and others. The research of Gershunsky (1987) is devoted to the use of computer technology in the educational process, Lomov (1989) focuses on the issues of increasing the effectiveness of the learning process and the use of computer technology in it, Mashbits (1986) defines the technology of computer training as a certain set of training programs of various types: from the simplest programs providing knowledge control to educational systems based on artificial intelligence.

The theoretical basis for the use of new information technologies as a means of teaching was considered in the works of Bork (1990), the methodical foundations of the problems of using

computers in physics lessons are devoted to the work of (Laptev, 1989). Izvozhikov (1991) defines information technologies as the computer technology (with the help of a computer) for processing, transferring, disseminating information, creating computing and software tools for informatics. Scientific approaches to the technological development of the learning process led to the study of modular training, the main provisions of the methodology, theory and practice of informatization of education and control were studied in the works of Doliner (2003) and Monakhov (1990). At the present time, a considerable amount of data on the essence of the information culture of the teacher has been accumulated. The content of this concept from a philosophical point of view is considered in the works of (Bespalko, 2002; Jenaabadi & Khosropour, 2014). The development of techniques for activating the independent educational activity of students in the process of mastering the modern information technologies was studied in the works of Robert (1994), the methodological and pedagogical foundations of distance education of the personality-oriented type were analyzed by Khutorskiy. The problem of the organization of the educational process, using modern pedagogical and information technologies was studied in the works of Polat (2007), the improvement of teaching methods in the A

At the present time, the quality of fundamental mathematical training in the university is very topical. In order to increase, above all, interest in the study of mathematical disciplines, and at the same time, the quality of fundamental mathematical knowledge, today it is necessary to apply ICT training in the course of mathematical preparation. In addition, there are a number of very good reasons for the need to introduce information technology in the teaching of

mathematical disciplines. These reasons are external in nature and are caused by global changes in society, public consciousness and intensive process of informatization of society. Among these reasons:

- Continuously and rapidly growing information flows and its rapid obsolescence;
- Reduction of teaching hours for the study of fundamental disciplines by the simultaneous expansion of the sections under study;
- Transfer of the center of gravity of the educational process to independent work of students;
- A drop in the level of mathematical preparation of the entrant;
- Increase the share of mass media, visual information flows (TV, Internet, etc.).

But besides these reasons, there are also internal reasons:

- Formalized nature of mathematical education;
- The congestion of mathematical courses with abstract theoretical material to the detriment of solving specific problems;
- The isolation of mathematical courses from modern computer technologies.

The use of ICT in the teaching of mathematical disciplines sets the effective peculiar logic of mastering subjects, and the training becomes more professionally oriented. This leads to increased motivation for learning, to independent search, analysis and use of information received, reveals the features of information technology tools in teaching. The main feature of ICT is that they provide innovative opportunities for independent and joint creative activity of teachers and trainees. Practical application of information technologies can improve or even partially replace in the educational process such conventional methods of teaching as the methods of oral presentation

of the teaching material (lecture, story, explanation, etc.), methods of fixing the acquired knowledge (practical and laboratory exercises), methods of independent work, methods of visual and practical training (Ranjbaran, 2014).

2. METHODOLOGY

In the educational process of higher education today, along with programming languages and spreadsheets, it is proposed to use such information technology tools as computer mathematics systems (SCM). SCM from the point of view of pedagogy is a didactic teaching tool, which, with the appropriate teaching methodology, allows optimizing the educational process, to intensify it. SCM from the point of view of informatics is information technology intended for automation of solving mathematical problems in various fields of science, engineering and education, integrating a modern user interface, solvers of mathematical problems (both numerical and analytical), and means for visualizing the results of (calculations). However, the use of this effective and powerful tool has one significant drawback, namely: the majority of SCM issues only the final answer without a solution. The optimal way to overcome this disadvantage is the development of programs that use SCM functions, which allow obtaining an expanded solution of certain types of tasks. This refers to the development of problem solvers of specific types, and not any, because the development of such a universal program is similar to the creation of artificial intelligence (Marbán & Mulenga, 2019; Garcíasantillán, 2019).

Currently, SCM is becoming increasingly popular, and is increasingly being used in training. This fact is confirmed by scientific research devoted to the use of computational mathematics in education systems and a number of publications devoted to this issue. Methodical aspects of the use of SCM Derive in facultative classes in secondary school are considered in the studies of Nirenburg (1997), and the technique of using SCM Maple, Math CAD in lecture sessions for the purpose of demonstrating various graphs and performing mathematical calculations in technical universities was developed by (Klimenko, 1990). Dyachenko (2000) developed the methodology of using Mathematica for the laboratory work in studying the course of higher mathematics at the university, Kapustina (2001) developed the theory and practice of creating and using Mathematica for the teaching of mathematical disciplines (on the example of differential geometry) in a pedagogical university, Plyasunova developed a laboratory workshop using SCM MathCAD in teaching mathematics to students of pedagogical universities. The methodology of using Mathematica in the process of mathematical training of specialists in the economic profile was developed by Belenkova (2002), a methodology was developed for using the MathCAD SCM program within the framework of the course Numerical Methods in the professional training of students at a pedagogical university. A number of authors suggest using SCM (MathCAD, Derive, Maple, Mathematica, MatLAB) for their theoretical development and the formation of experience in these programs in the course of studying the discipline Information technology in mathematics, Chernyaket al. (2003) use the SCM MathCAD for the mathematical preparation of future economists. The possibilities of studying the course of differential

equations realized by SCM are investigated in the works of (Bezruchko, 2014; Akter & Rahman, 2018; Kelik & Wardah, 2019).

One of the areas of application of SCM in training is organization of problem solving. Erdniev (1992) notes that the problem is the main cell of mathematics, and Talysina argues that the mastery of the material is impossible without solving problems, since the process of learning knowledge is the process of applying them. To solve problems are resorted to in the presentation of new material and in its consolidation. Therefore, it is necessary to find ways and forms of training that would allow students to learn the necessary material in the time allotted for studying, while receiving the maximum amount of skills, knowledge and skills. Particularly topical is the use of specially developed multimedia resources and the optimal organization of independent activity of students. We propose to use the computer mathematical system Maple, freely installed on any personal computer, for educational purposes. Maple can be used in free mode for both labor-intensive calculations, and as an ideal tool for self-testing, finding and fixing errors in solving problems.

The use of the Maple environment as a means for carrying out auxiliary calculations in the process of solving learning problems allows us to implement the following methodological goals: strengthening the motivation in learning, increasing the visibility of practical exercises, reducing the training time, freeing from routine calculations; due to the release of time, it becomes possible to focus attention on the ideological side of the question under study. Maple provides an opportunity to introduce in the educational process tasks that previously were not solved in practical exercises. Of course, using Maple in the educational process will not be able to replace the

traditional forms of teaching, but will be able to supplement and enrich them. Its competent application will significantly intensify the educational process, highlight the phenomenon under study or it is also important to prepare a student for the qualified use of a computer in educational activities, make the learning process more attractive and interesting. Maple in the educational process implements a number of didactic. Possibility of the following can be attributed to it:

- Immediate feedback between the user and ITC tools, which determines the implementation of the interactive dialogue;
- Visualization of educational information about the object under study, the process (visual representation on the screen: the object, its constituent parts or their models, the process or its model, the graphic interpretation of the studied regularity, the process being studied);
- Modeling and interpretation of information about the objects being studied or studied, their relationships, processes, phenomena - both real and virtual (representation on the screen of a mathematical, information-descriptive, visual model is adequate to the original);
- Archiving, storing large volumes of information with the possibility of easy access to it, its transfer, replication;
- Automation of the processes of computing, information retrieval activity, as well as processing the results of the training experiment with the possibility of the repeated recurrence of the fragment or the experiment itself;
- Automation of the processes of information and methodical support, organizational management of training activities and control over learning outcomes.

Maple has many powerful tools for calculating expressions with one or more variables. The system can be used for solving problems of differential and integral calculus, calculating limits, series expansions, summation of series, multiplication, integral transformations (such as the Laplace transform, Z-transformation, Mellin or Fourier transformation), as well as for studying continuous or piecewise-continuous functions. For technical applications in Maple, directories of physical constants and units of physical quantities with automatic recalculation of formulas are included. Graphical tools Maple support both 2D and 3D graphics. It is possible to construct the graphs of functions in the logarithmic, double logarithmic, parametric, phase, polar and contour forms. Unlike other packages, it can graphically represent inequalities, implicitly defined functions, solutions of differential equations, and root hodographs. Maple allows you to build surfaces and curves in a three-dimensional view, including surfaces defined by explicit and parametric functions, as well as solutions of differential equations. Surfaces are presented not only in a static form, but also in the form of two- or three-dimensional animation, which can be used to display processes that occur in real time. The Maple package has a powerful device for symbolic computation.

Let us consider the possibilities that SCM Maple gives in studying the course of integral equations. Integral equations are a content-rich, a rapidly developing section of mathematics closely related to its other sections and applications. The course of integral equations combines knowledge, skills, abilities, methods and procedures developed in the differential and integral calculus of functions of one and several variables, information from linear algebra and the theory of polynomials, complex analysis and the theory of

elementary functions, geometry of curves and series theory. This section of mathematics plays a big role in the fundamental preparation of the future specialist in terms of forming a scientific world outlook, a certain level of mathematical culture, methodological culture, especially in such components as understanding the essence of the applied and practical orientation of teaching mathematics, mastering the method of mathematical modeling, training inter-subject communications. Studying the course of integral equations and its methods gives another tool for understanding the world in which we live, allows us to form a figurative and scientific understanding of the real physical space. That is why the study of this section requires special attention. Consider the possibilities of SCM Maple for solving integral equations (Fateminasab, 2014).

Example 1. Solve the Fredholm integral equation:

$$u(t) = t^2 + 2 \int_0^1 (1 + 3ts)u(s)ds.$$

Solution: 1-step. Write an integral member of the equation in the following form:

$$\int_0^1 (1 + 3ts)u(s)ds = \int_0^1 u(s)ds + 3t \int_0^1 su(s)ds.$$

2-step. Denote

$$Q_1 = \int_0^1 u(s)ds, \quad Q_2 = \int_0^1 su(s)ds.$$

3-step. The original equation can be represented as the following algebraic equation:

$$u(t) = t^2 + 2Q_1 + 6Q_2t.$$

4-step. Calculate Q_1 and Q_2 :

$$Q_1 = \int_0^1 u(s) ds = \int_0^1 [s^2 + 2Q_1 + 6Q_2 s] ds = \left[\frac{1}{3} s^3 + 2Q_1 s + 3Q_2 s^2 \right]_0^1 = \frac{1}{3} + 2Q_1 + 3Q_2,$$

Or

$$-Q_1 - 3Q_2 = 1/3,$$

$$Q_2 = \int_0^1 su(s) ds = \int_0^1 s(s^2 + 2Q_1 + 6Q_2 s) ds = \left[\frac{1}{4} s^4 + Q_1 s^2 + 2Q_2 s^3 \right]_0^1 = \frac{1}{4} + Q_1 + 2Q_2,$$

Or

$$-Q_1 - Q_2 = 1/4.$$

5-step. Consider the system of linear algebraic equations concerning to Q_1 and Q_2 :

$$\begin{cases} -Q_1 - 3Q_2 = 1/3, \\ -Q_1 - Q_2 = 1/4. \end{cases}$$

6-step. Using the Cramerformula, we find Q_1 and Q_2 :

$$Q_1 = D_1 / D, \quad Q_2 = D_2 / D,$$

Where

$$D = \begin{vmatrix} -1 & -3 \\ -1 & -1 \end{vmatrix} = -2 \neq 0, \quad D_1 = \begin{vmatrix} 3^{-1} & -3 \\ 4^{-1} & -1 \end{vmatrix} = -\frac{1}{3} + \frac{3}{4} = \frac{12}{5}, \quad D_2 = \begin{vmatrix} -1 & 3^{-1} \\ -1 & 4^{-1} \end{vmatrix} = -\frac{1}{4} + \frac{1}{3} = \frac{1}{12}.$$

$$Q_1 = D_1 / D = -5/24, \quad Q_2 = D_2 / D = -1/24.$$

7-step. Putting the values of Q_1 and Q_2 into the algebraic equation, we find the exact solution of the integral equation:

$$u(t) = t^2 - \frac{1}{4}t - \frac{5}{12}.$$

To study the behavior of the solution we will use the computer program system Maple.

>restart;

>u:=t->t^2-t/4-5/12;

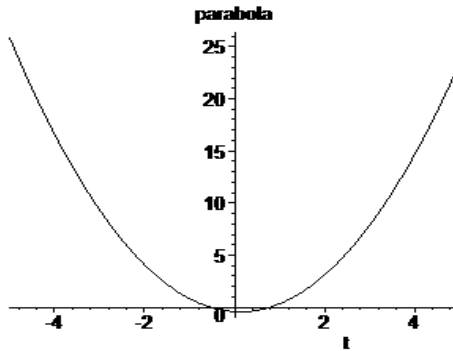
$$u := t \rightarrow t^2 - \frac{1}{4}t - \frac{5}{12}$$

>u (t);

$$t^2 - \frac{1}{4}t - \frac{5}{12}$$

>plot (u(t),t=-5..5,color=black,title='parabola');

>



>restart;

>f:=(t,u)->t^2-t/4-5/12-u;

$$f := (t, u) \rightarrow t^2 - \frac{1}{4}t - \frac{5}{12} - u$$

>f(t,u);

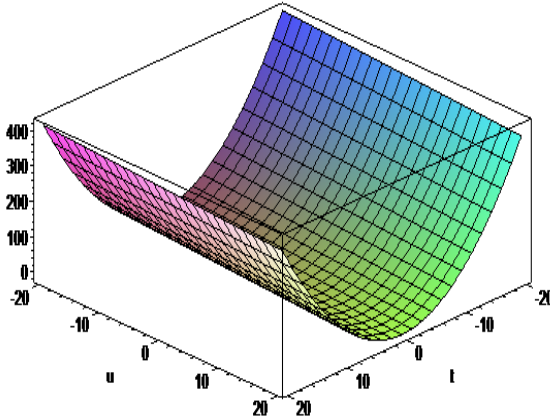
$$t^2 - \frac{1}{4}t - \frac{5}{12} - u$$

>a:=-20..20;b:=-20..20;

$$a := -20 .. 20$$

$$b := -20 .. 20$$

>plot3d (f(t,u),t=a,u=b,axes=boxed);



>

Example 2. Solve the Fredholm integral equation

$$u(x, t) = x^2 + t^2 + \lambda \int_0^1 \int_0^1 (xs_2 + ts_1)u(s_1, s_2) ds_1 ds_2.$$

Solution:

1.

$$\int_0^1 \int_0^1 (xs_2 + ts_1)u(s_1, s_2) ds_1 ds_2 = x \int_0^1 \int_0^1 s_2 u(s_1, s_2) ds_1 ds_2 + t \int_0^1 \int_0^1 s_1 u(s_1, s_2) ds_1 ds_2.$$

$$2. Q_1 = \int_0^1 \int_0^1 s_2 u(s_1, s_2) ds_1 ds_2, \quad Q_2 = \int_0^1 \int_0^1 s_1 u(s_1, s_2) ds_1 ds_2.$$

$$3. u(x, t) = x^2 + t^2 + \lambda Q_1 x + \lambda Q_2 t.$$

4.

$$Q_1 = \int_0^1 \int_0^1 s_2 u(s_1, s_2) ds_1 ds_2 = \int_0^1 \int_0^1 s_2 [s_1^2 + s_2^2 + \lambda Q_1 s_1 + \lambda Q_2 s_2] ds_1 ds_2 =$$

$$= \int_0^1 \int_0^1 [s_2 s_1^2 + s_2^3 + \lambda Q_1 s_1 s_2 + \lambda Q_2 s_2^2] ds_1 ds_2 = \frac{1}{6} + \frac{1}{4} + \frac{\lambda Q_1}{4} + \frac{\lambda Q_2}{3},$$

Or

$$(1 - \lambda/4)Q_1 - (\lambda/3)Q_2 = 5/12.$$

$$Q_2 = \int_0^1 \int_0^1 s_1 u(s_2, s_1) ds_1 ds_2 = \int_0^1 \int_0^1 s_1 [s_1^2 + s_2^2 + \lambda Q_1 s_1 + \lambda Q_2 s_2] ds_1 ds_2 =$$

$$= \int_0^1 \int_0^1 [s_1^3 + s_1 s_2^2 + \lambda Q_1 s_1^2 + \lambda Q_2 s_1 s_2] ds_1 ds_2 = \frac{1}{4} + \frac{1}{6} + \frac{\lambda Q_1}{3} + \frac{\lambda Q_2}{4},$$

Or

$$-(\lambda/3)Q_1 + (1 - \lambda/4)Q_2 = 5/12.$$

$$5. \begin{cases} \left(1 - \frac{\lambda}{4}\right)Q_1 - \frac{\lambda}{3}Q_2 = \frac{5}{12}, \\ -\frac{\lambda}{3}Q_1 + \left(1 - \frac{\lambda}{4}\right)Q_2 = \frac{5}{12}. \end{cases}$$

$$6. Q_1 = \frac{5(12 + \lambda)}{144 - 72\lambda - 7\lambda^2}, \quad Q_2 = \frac{5(12 + \lambda)}{144 - 72\lambda - 7\lambda^2}.$$

$$7. u(x, t) = x^2 + t^2 + \frac{5\lambda(12 + \lambda)}{144 - 72\lambda - 7\lambda^2} (x + t).$$

To study the behavior of the solution we will use the computer program system Maple.

```
>restart;
```

```
>u:=(x,t)->x^2+t^2+x+t;
```

$$u := (x, t) \rightarrow x^2 + t^2 + x + t$$

```
>u(x,t);
```

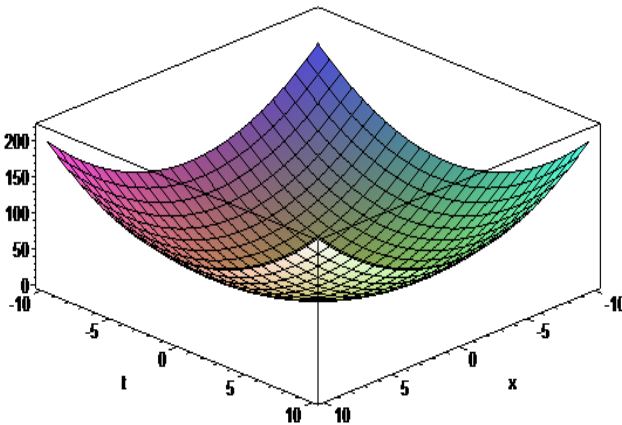
$$x^2 + t^2 + x + t$$

```
>a:=-10..10;b:=-10..10;
```

$$a := -10 .. 10$$

$$b := -10 .. 10$$

```
>plot3d(u(x,t),x=a,t=b,axes=boxed);
```



3. CONCLUSION

In conclusion, we note that SCM should be used as ICT tools in training. The most effective use of SCM for pedagogical purposes can be achieved with the development in its environments of software

products for educational purposes and computerized textbooks, problem books, test books, electronic dictionaries, reference books, encyclopedias, numerical data, computer educational materials. In addition, the introduction of SCM Maple into the educational process makes it possible to implement the following methodological goals: strengthening the motivation in the study; increased visibility; liberation from routine calculations; Introduction in the educational process of tasks that were not previously solved in practical exercises; achievement of activation of independent educational and cognitive activity of students; formation of a scientific world outlook, a certain level of mathematical culture, methodical culture; understanding the essence of the applied and practical orientation of teaching mathematics, mastering the method of mathematical modeling.

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