Volume 2, Issue 11, November 2024 ISSN (E): 2938-3757

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DESIGN OF TRAINING ON THE BASIS OF A PACKAGE OF PRACTICAL PROGRAMS FOR THE EFFECTIVE ORGANIZATION OF THE CALCULATION OF PROBLEMS RELATING TO THE APPLICATIONS OF THE DEFINITE INTEGRAL

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Abstract
In the article is a package of practical programs. It refers to a set of interconnected programs for solving specific class problems.

Keywords: Exact integral, application, calculation, ICT, efficiency, system.

Introduction

1) Problematic - directed. It is used in problem areas such as control functions, structured data , and processing algorithms.
2) Design automation. It is used in the works of designers and technologists who develop drawings, schemes, diagrams.
3) General oriented. Systems that support computer technologies, such as text editors and table processors, graphic editors, database management systems.
4) Office. Provides management of organizational activities of the office. It includes organizers (notebooks and phone books, calendars, presentations) , translators, text recognition tools.
5) Desktop publishing systems - word processors that are somewhat powerful in terms of functionality.
6) Artificial intelligence systems. It supports natural language communication; expert systems that can provide recommendations to users in various situations; covers intelligent application software packages that solve practical problems without programming.

Definition of application packages. The term "application packages" is used to refer to a set of programs of different complexity and definition. As noted earlier, a clear line cannot be drawn between a software product that is an application program and an application program package. As more and more software packages are developed, there are new definitions to understand under software package.

According to modern views, application software packages are a set of collaborative programs to solve a defined class of problems. Application software packages are always intended for users with specified skills in the field of programming and the problems solved by using these application software packages.

The fact that the programs that make up the packages of application programs can be together means that they can be used interchangeably, and that the structures used by the control data and information arrays are common. In addition, application packages should be considered as independent software products, as a separate type of application.

Based on the definition, the following general features of application packages can be distinguished.

consists of several software units.

- The package is designed to solve a defined class of problems.
- Within its class, a package has defined universality, that is, it allows solving all or almost all problems in that class.

The package provides controls that allow you to select specific options from those provided. The package allows you to set specific terms of use.

The package was developed taking into account the possibilities of its use within the organization for which it was created and meets the general requirements for a software product.

The documentation and package usage methods are intended for a user with a specified level of expertise in the subject matter covered by the package.

In teaching this course, e-learning, distance learning, group and collective, as well as individual learning technologies, graphical organizers, the Socratic method, and interactive methods based on mathematics are effective.

The creation of each program or program package is based on a strictly defined technology based on the presence of certain capabilities and the absence of certain capabilities . We can also create our own software based on our own technology .

Analyzing the above capabilities of the application software package, the effective aspects of their use in the course of the lesson can be described as follows : 1. The student will have the skills to use the high capabilities of programming languages ;

, it becomes possible to analyze all the solutions of a given practical problem and to choose an effective method of solving the problem ;

3. The topic is mastered by students in a systematic and logical way .
4. The package of practical programs serves as a necessary software reserve for further scientific research as a program library;
5. The possibility of completing and changing the package as needed directs the student's future cognitive activity towards specific goals ;
6. The student's confidence in his knowledge and ability to solve practical problems increases, motivation for new creative research appears in him.

Thus, a specific software package is used to solve any problem

Nowadays , it is designed for users to solve various practical problems , it is ready for those who

do not need much programming knowledge

it is not so difficult to learn,

a library of scientific programs, electronic manuals and most importantly , a number of mathematical application packages have been created that perform standardized, mass calculations .

Currently, for those who do not know programming well or do not have the opportunity to learn, there are ready-made scientific software packages, electronic manuals and software tools designed to perform typical calculations - mathematical application programs *packages* (ADP).

In particular, relatively powerful packages of computer algorithms are Mathematica , *Maple*, *Matlab*, *MathCAD*, *Derive* and *Scientific Workplaces* . The first two of these are designed for professional mathematicians and are characterized by a wealth of possibilities and complexity of use.

The MatLab program is designed for working with matrices and automatic control and processing of signals. MathCAD and Derive, on the other hand, are very easy to use and ensure that typical student requirements are met.

the exact int e gral **using MathCAD** .

An op e rator is used to calculate $\int_a^b$ **the exact int e gral** . In this case, **Ctrl+** keys are used to numerically calculate the value of the exact integral , and → keys are used to get a symbolic (formula) result .

Example 1. $\int_0^{\frac{\pi}{6}} \sin(x)\,dx = 0.134$

Example 2. $\int_0^{\frac{\pi}{6}} \sin(x)\,dx \to 1 - \frac{\sqrt{3}}{2}$

It can be seen that the results are displayed numerically (by using a simple equation) or symbolically (by selecting → b e lgi) depending on the selection .

General

concepts of approximating exact integers

exact integrals is closely related to the geometric solution of the problem about the surface of a curved trapezium . From the bottom with the curve [*a* , *b*] on the OX axis , from the top with the graph of the continuous function *y* □□ *f* (*x*) that takes a positive value , from the sides *x* □□ *a* and *x* □□ *b* of straight lines k The face of the linear trapezoid is the figure drawn by the points (Fig. 4.1).

$$\int_a^b f\,(x)dx = F(b) - F(a)$$

' can be accurately calculated by the Euton-L e ybnis formula. where *F* (*x*) -b is *f* (*x*) initial function of the function. As mentioned above , when it is not possible to calculate the initial function using integration rules and formulas, it is approximated using integral sums .

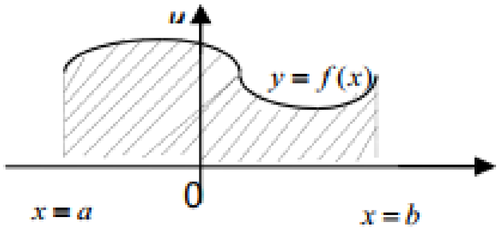

Figure 4.1. The g

e om e tric meaning of the exact int e gral is d e mak to find the surface of the hatched area in Figure 4.1

.

In addition to numerical calculations, MathCAD also performs symbolic calculations . The result of
these d e g calculations can be described analytically

There are two main tools for performing symbolic calculations :
- Symbolics menu ;
- From the Mathematical pane to the Symbolic pane .

These tools are used in more complex symbolic calculations. Now we will consider the simplest method of simple *symbolic calculation, that is, one of* the most frequently used methods - *the symbolic equal sign (*) method. →Below is the procedure for using this method :
1. Select the Calculus Toolbar section from the math panel .
2. Select Calculus (Calculation) from the opened pane window and extract the indefinite integral (as an example) .
3. The input fields are filled, that is , the name of the function and the name of the variable are entered.
4. A wildcard (→) character is entered. The result is generated.

Usually, finding the initial function of a function under the integral
is mathematically very difficult, and for some functions
it is absolutely impossible to find the initial function. Therefore, the development of algorithms and creation of programs for calculating
exact integrals with the required
accuracy are considered urgent issues.
According to the definition of exact integral calculation , u

$$\lim_{max\Delta x_k \to 0} \sum_{k=1}^{n} f(\xi_k)\Delta x_k$$

t e ng to the limit . Here Δx_k – [a , b] the length of the k-part when the k - space is divided into n parts, ξ_k - kk is a point inside the space. All methods of approximating Δthe exact int e gral are based on the above formula, x_k and Various approximate ξintegration formulas are created by choosing in different ways. The most commonly used in practice are rectangles, trapeziums, and Simpson's formulas.

Method of rectangles

Int e gral historically appeared in relation to calculating the surface of figures divided by curves , in particular the surface
of a curved trapezium . This method is also based on approximate calculation by filling the surface with rectangles . The basis of the trap is [a ; b] we divide the square into n squares with points x 1 , x 2 , ..., x_{n-1}
. Then the length of the division interval
$h = \frac{b-a}{n}$ is represented by the formula. $x_0 = a$ d e b, $x_i = x_{i-1} + h$ denote the points , where i =1,2,3,..., n . The nodes of the interval [a , b] are from $x_1, x_2, x_3, ..., x_n$
vertical parallel straight lines until they intersect with the curve y = $f(x)$ *and* the ordinates of the points of intersection

$y(x_1), y(x_2),\ldots, y(x_i),\ldots$ like We find the surfaces of a rectangle whose ordinate length is equal to $y(x_i)$ in each interval :

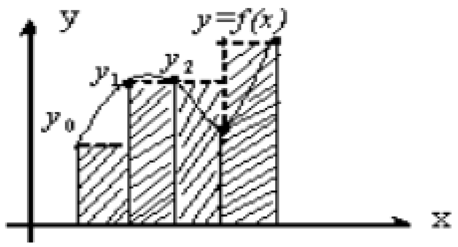

Fig. 4.3 We add the surfaces of the resulting rectangles :

$$S = h \cdot \big(y(x_1) + y(x_2) + y(x_3) + \cdots + y(x_n)\big) = h \cdot \sum_{k=1}^{n} y(x_k)$$

When calculating surfaces k □ 1,2,3,..., n *If we take* d e b, since the right rectangles are obtained with respect to vertical straight lines, the formula of the right rectangle method is k e :

$$S = \int_a^b f(x)dx \approx h[f(a+h) + \cdots + f(a+n\cdot h)] = h \cdot \sum_{k=1}^{n} f(a+kh)$$

k □□ 0,2,..., $n-1$ d e b , since left rectangles are obtained with respect to vertical straight lines, the formula for the left rectangle method is:

$$S = \int_a^b f(x)dx \approx h[f(a) + f(a+h) + \cdots + f(a+(i-1)\cdot h)] == h \cdot \sum_{k=1}^{n} f(a+kh)$$

If the function $f(x)$ is twice differentiable , the calculation error of the working formula $R_n = \frac{(b-a)^3}{2n^2} f''(\xi)$, $a \leq \xi \leq b$ determined by the formula.

Example: s:□□ $\int_0^1 \frac{1}{1+x} dx$ *need to calculate the surface .*

Program codes corresponding to the algorithms developed for the **rectangular method of** exact integral approximation are included in the MathCAD program.

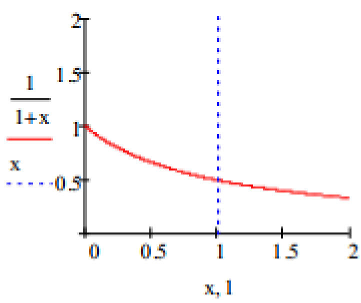

Figure 4.4

The programming codes corresponding to the software package developed according to this method were entered into the working window of MathCAD in the following order.

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```
T_u(a,b,n,f) := | h ← (b − a)/n
                | s ← 0
                | for j ∈ 1..n
                |   | x_j ← a + h·(j)
                |   | s ← s + f(x_j − h/2)
                | s ← s·h
                | s
```

$f(x) := \frac{1}{1+x}$ By entering the integral subfunction and using the procedure, the following result can be obtained:

T_u(0 , 1 , 100 , f) □□ 0.693

So, the value of the definite integral under the f function obtained with a certain step in the interval [0,1] is equal to 0.693.

Trapezium method. This

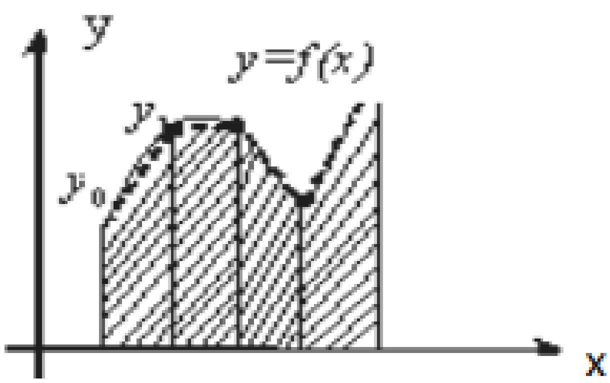
$$\int_a^b f(x)dx = \frac{b-a}{2n}\left[f(a)+f(b)+2\sum_{k=1}^{n-1} f\left(a+k\cdot\frac{b-a}{n}\right)\right]+R_n$$

the formula is called **the trapezoidal formula** .

$f(x)$ the function $[a,b]$ has a continuous derivative, $f''(x)$ **(***)** is the residual term in the formula

$$R_n = -\frac{(b-a)^3}{12n^2} f''(c) \quad (a \le c \le b)$$

will have an appearance.



Example: $s :□□ \int_0^1 \frac{1}{1+x}dx$ **The program codes corresponding to the software package developed for the trapezoidal method of** surface calculation **are inserted into the working window of MathCAD in the following order.**

Volume 2, Issue 11, November 2024 **ISSN (E):** 2938-3757

```
Trapet_u(a,b,n,f) := | h ← (b − a)/n
                     | s ← 0
                     | for  j ∈ 1..n − 1
                     |     | x_j ← a + h·j
                     |     | s ← s + f(a + x
                     | s ← s + (f(a) + f(t / 2
                     | s ← s·h
                     | s
```

$f(x) := \frac{1}{1+x}$ By entering the integral subfunction and using the procedure, the following result can be obtained :

Trapezoid_u(0 , 1 , 100 , f) □□ 0.6931534

So, the value of the exact integral under the f function obtained with a certain step in the interval [0,1]

is equal to 0.6931534.

Simpson (parabolas) method . This

$$\int_a^b f(x)dx = \frac{b-a}{6n}\left[f(a)+f(b)+2\sum_{k=1}^{n-1} f\left(a+2k\cdot\frac{b-a}{2n}\right)+\right.$$

$$\left.+4\sum_{k=0}^{n-1} f\left(a+(2k+1)\cdot\frac{b-a}{2n}\right)\right]+R_n$$

formula **Simpson (parabolas) formula** is called

$\mathbf{f(x)}$function $[\mathbf{a,b}]$is continuous $\mathbf{f^{(4)}(x)}$ has the derivative , **(****)** the remaining term in the formula

$$R_n = -\frac{(b-a)^5}{2880n^4} f^{(4)}(c) \quad (a \le c \le b)$$

will have an appearance.

Example: $s{:}□□\int_0^1 \frac{1}{1+x}dx$ **program codes corresponding to algorithms developed for the Simpson (parabolas) method of exact integral approximation are included in the MathCAD program.**

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```
Simpson(a,b,n,f) := | m ← n/2
                    | h ← (b − a)/(2·m)
                    | s ← f(a) + f(b)
                    | s1 ← 0
                    | s2 ← 0
                    | for k ∈ 1..m − 1
                    |     | x_k ← a + 2·h·k
                    |     | s1 ← s1 + f(x_k)
                    | for k ∈ 1..m
                    |     | x_k ← a + (2k − 1)h
                    |     | s2 ← s2 + f(x_k)
                    | s ← h/3 (s + 2·s1 + 4s2)
                    | s
```

an int e gral subfunction and using the procedure, the following result can be obtained:

Simpson (0 , 1 , 100 , f) □□ 0.6931472

For example , the value of the exact integral under the f function obtained with a certain step in the interval [0,1] is equal to 0.6931472 .

Program based on the above algorithms by entering the given values the supply. The results obtained from them:

By the method of right rectangles: *S=5.4236673* 2)

trapezium method: *S = 5,41566723* 3)

In Simpson's method: *S=5 ,4166666*

All the obtained results are close to the exact solution. However , the best result of the methods was the Simpson method, and the worst result was obtained from the rectangular method. Logically, the results are also true. Therefore, the algorithm and programs given above are correct and suitable for practical use.

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