Application of Mathematical Packages in Teaching Higher Mathematics

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ABSTRACT

The Strategy for the Development of the Information Technology Industry in Uzbekistan for 2022-2026 and for the period up to 2030 emphasizes that information and communication technologies contribute to improving the quality of educational services. At the same time, it is noted that a necessary condition for the development of the IT industry is “a high level of knowledge of school and university graduates in mathematics and natural sciences. The decline of this level in recent years is a direct threat to such development.”

Keywords: mathematics, mathematical package, information technology, software package, quality of education, pedagogy.

At present, technologies are developing so rapidly that the entire education system is faced with the task of teaching not only a certain amount of knowledge, but also involving students in activities that help to acquire knowledge and practical skills. This concept is called lifelong learning. The problem of data deterioration is a serious threat to student teachers, since their professional life will be closely connected with the use and development of new information technologies.

Based on these considerations, it is necessary to revise the work programs of universities, taking into account the introduction of mathematical packages in the educational process. Now there is no such area in which modern information technologies would not be used.

. Mathematical programs make it possible to implement by standard means the most important principles from a didactic point of view "From simple to complex" and "Maximum visibility and convenience of work." These principles develop and form in students the skills of independent cognitive activity necessary for further education at a university.

What are the advantages of a lesson using a computer mathematics system.

The use of mathematical programs enables students to apply to solve the current educational problem.

1.Standard

2.Deep

3.In-depth solution with elements of scientific research

Implementation of the principle "Visibility and convenience" to a certain extent

also provided by the standard features provided

most math packages.

With the help of modern technology and methods, it is possible to facilitate the assimilation of the material. The methodology for using information technology in general and training programs in particular involves:

1) improvement of the learning management system at various stages of classes;

2) strengthening the motivation for learning;

3) improving the quality of education and upbringing;

With the help of the use of training programs, the following didactic tasks can be solved:

1) acquire basic knowledge on the subject, systematize the acquired knowledge;

2) to form self-control skills;

3) to form motivation for learning in general and for mathematics in particular;

4) provide educational and methodological assistance to students in independent work on educational material

Let us consider in more detail the methodology of using calculations and computer experiments in the study of the course "Introduction to Mathematical Analysis".

As an example, consider the use of the Maple mathematical package in one of the main courses of mathematical analysis "Definite Integrals".

Let us first consider the solution of examples by the analytical method. After we consider the same task in Maple.

Example 1 . Calculate the area of the area bounded by Pascal's snail.

$r = 2 + \cos\varphi$

Solution: use the formula $S = \frac{1}{2}\int_{\alpha}^{\beta} r^2(\varphi)d\varphi$ We find the limit of the integral as follows. Draw a curve in polar coordinates for the function $r = 2 + \cos\varphi$. Let's create a table for the value. ρ and φ

φ	0^0	30^0	45^0	60^0	90^0	120^0	135^0	150^0	180^0
$\cos\varphi$	1	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0	$-\frac{1}{2}$	$-\frac{\sqrt{2}}{2}$	$-\frac{\sqrt{3}}{2}$	-1
$r = 2 + \cos\varphi$	3	$2+\frac{\sqrt{3}}{2}$	$2+\frac{\sqrt{2}}{2}$	2,5	2	1,5	$2-\frac{\sqrt{3}}{2}$	$2-\frac{\sqrt{2}}{2}$	1

the function is an even function, the graph of the function is symmetrical in terms of values relative to the horizontal axis, to plot the graph of the function, draw a polar line r; We mark the values given in Table 1 along the r axes and build a graph. We get a closed curve called Pascal's snail. (Figure 1)

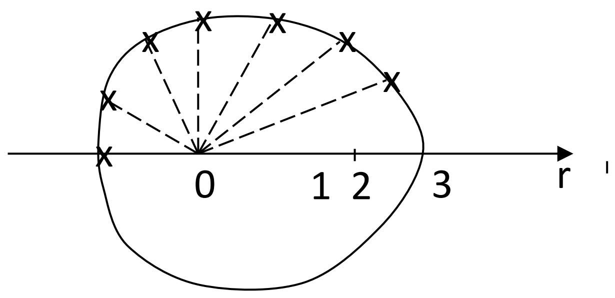


Рис 1

the area of the resulting figure is equal to the following.

$$S=\frac{1}{2}\int_{0}^{2\pi}(2+\cos\phi)^2\,d\phi=\frac{1}{2}\int_{0}^{2\pi}\left(4+4\cos\phi+\frac{1+\cos2\phi}{2}\right)d\phi=$$

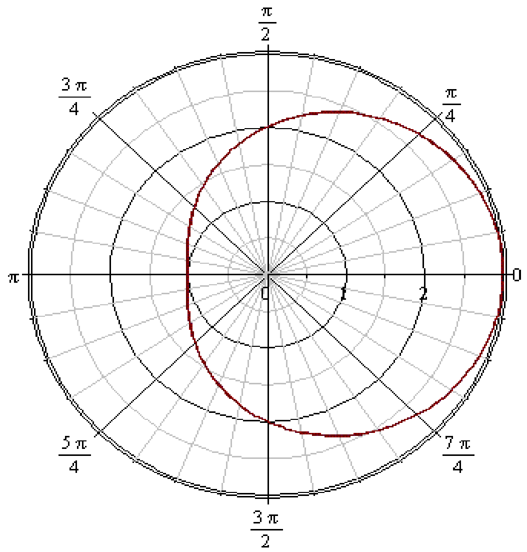
$$=\frac{1}{2}\left(4,5\phi+4\sin\phi+\frac{1}{4}\sin2\phi\right)\Bigg|_{0}^{2\pi}=4,5\pi\quad(\kappa v.e\partial.)$$

Consider the same task in Maple

This can be drawn easily and accurately using the Maple software.

> *with*(*plots*) :

> *polarplot*(2 +cos(theta), theta = 0 ..2·Pi, *scaling* = *constrained*);



> *with*(*Student*[*Calculus1*]) :

>

> *IntTutor*$\left(\frac{1}{2}(2+\cos(\varphi))^2\right)$;

$$\int_0^{2\pi} \frac{(2+\cos(x))^2}{2}\, dx$$

$$= \int_0^{2\pi} \left(\frac{\cos(x)^2}{2} + 2\cos(x) + 2 \right) dx$$

[rewrite, $\frac{1}{2}(2+\cos(x))^2 = 1/2\cos(x)^2 + 2\cos(x) + 2$]

$$= \int_0^{2\pi} \frac{\cos(x)^2}{2}\, dx + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[sum]

$$= \frac{\left(\int_0^{2\pi} \cos(x)^2\, dx \right)}{2} + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[constantmultiple]

$$= \frac{\left(\int_0^{2\pi} \left(\frac{\cos(2x)}{2} + \frac{1}{2} \right) dx \right)}{2} + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[rewrite, $\cos(x)^2 = 1/2(\cos(2x)) + \frac{1}{2}$]

$$= \frac{\left(\int_0^{2\pi} \frac{\cos(2x)}{2}\, dx \right)}{2} + \frac{\left(\int_0^{2\pi} \frac{1}{2}\, dx \right)}{2} + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[sum]

$$= \frac{\left(\int_0^{2\pi} \cos(2x)\, dx \right)}{4} + \frac{\left(\int_0^{2\pi} \frac{1}{2}\, dx \right)}{2} + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[constantmultiple]

$$= \frac{\left(\int_0^{4\pi} \frac{\cos(u)}{2}\, du \right)}{4} + \frac{\left(\int_0^{2\pi} \frac{1}{2}\, dx \right)}{2} + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[change, $u = 2x$, u]

$$= \frac{\left(\int_0^{4\pi} \cos(u)\, du \right)}{8} + \frac{\left(\int_0^{2\pi} \frac{1}{2}\, dx \right)}{2} + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[constantmultiple]

$$= \frac{\left(\int_0^{2\pi} \frac{1}{2}\, dx \right)}{2} + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[cos]

$$= \frac{\pi}{2} + \int_0^{2\pi} 2\cos(x)\, dx + \int_0^{2\pi} 2\, dx$$

[constant]

$$= \frac{\pi}{2} + 2\left(\int_0^{2\pi} \cos(x)\, dx \right) + \int_0^{2\pi} 2\, dx$$

[constantmultiple]

$$= \frac{\pi}{2} + \int_0^{2\pi} 2\, dx$$

[cos]

$$= \frac{9\pi}{2}$$

[constant]

$$\int_0^{2\pi} \frac{1}{2}(2+\cos(x))^2\,dx = \frac{9}{2}\pi$$

>

Example 2 Find the length of the curve.

$$r = 3\cdot e^{\frac{3\varphi}{4}},\ 0 \le \varphi \le \frac{\pi}{3}.$$

Solution: Curve $r = 3\cdot e^{\frac{3\phi}{4}}$ given in polar coordinates. Let's use the formula

$$l = \int_\alpha^\beta \sqrt{r^2(\varphi) + [r'(\varphi)]^2}\,d\varphi$$

We find $r'(\varphi)$.

$$r' = \left(3\cdot e^{\frac{3\varphi}{4}}\right)' = 3\cdot e^{\frac{3\varphi}{4}}\cdot\frac{3}{4} = \frac{9}{4}\cdot e^{\frac{3\varphi}{4}}.$$

$$r^2 + (r')^2 = 9\cdot\left(r^{\frac{3\varphi}{4}}\right)^2 + \frac{81}{16}\cdot\left(r^{\frac{3\varphi}{4}}\right)^2 = \frac{225}{16}\cdot\left(r^{\frac{3\varphi}{4}}\right)^2$$

$$L = \int_0^{\pi/3}\sqrt{\frac{225}{16}\cdot\left(r^{\frac{3\varphi}{4}}\right)^2}\,d\varphi = \frac{15}{4}\int_0^{\pi/3} e^{\frac{3}{4}\varphi}\,d\varphi = \frac{15}{4}\cdot\frac{4}{3}e^{\frac{3}{4}\varphi}\Big|_0^{\pi/3} =$$

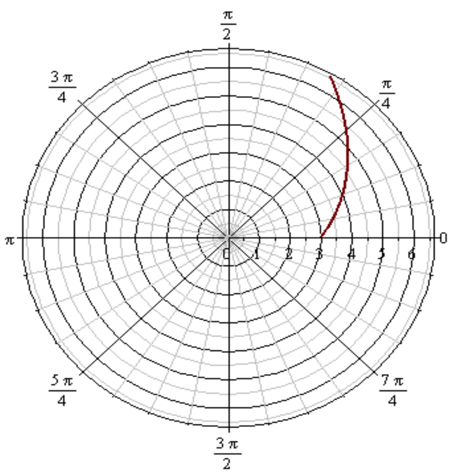
$$= 5\cdot e^{\frac{3}{4}\cdot\frac{\pi}{3}} - 5e^0 = 5\cdot(e^{\pi/4} - 1)\ (\text{ед}).$$

Consider the same task in Maple

We draw a graph of a function using the Maple program.

> $with(plots):$

> $polarplot\left(3\cdot e^{\frac{3\cdot(\text{theta})}{4}}, \text{theta} = 0..\frac{\text{Pi}}{3}, scaling = constrained\right);$



> $r := 3\cdot\exp\left(\frac{3}{4}x\right);$

$$r := 3\,e^{\frac{3}{4}x}$$

> $\frac{d}{dx} r;$

$$\frac{9}{4}e^{\frac{3}{4}x}$$

> $r^2 + \left(\frac{d}{dx} r\right)^2;$

$$\frac{225}{16}\left(e^{\frac{3}{4}x}\right)^2$$

> $with(Student[Calculus1]):$

>

> $IntTutor\left(\sqrt{\frac{225}{16}\left(e^{\frac{3}{4}x}\right)^2}\right);$

$$\int_0^{\frac{\pi}{3}} \frac{15\sqrt{\left(e^{\frac{3x}{4}}\right)^2}}{4}\,dx$$

$$= \frac{15\left(\int_0^{\frac{\pi}{3}} \sqrt{\left(e^{\frac{3x}{4}}\right)^2}\,dx\right)}{4} \qquad [constantmultiple]$$

$$= \frac{15\left(\int_0^{\frac{\pi}{4}} \frac{4e^u}{3}\,du\right)}{4} \qquad \left[change, u = \frac{3x}{4}, u\right]$$

$$= 5\left(\int_0^{\frac{\pi}{4}} e^u\,du\right) \qquad [constantmultiple]$$

$$= 5e^{\frac{\pi}{4}} - 5 \qquad [exp]$$

$$\int_0^{\frac{1}{3}\pi} \frac{15}{4}\sqrt{\left(e^{\frac{3}{4}x}\right)^2}\,dx = 5e^{\frac{1}{4}\pi} - 5$$

Example 3. Find the surface area of the figure obtained as a result of the rotation of the curve $3y - x^3 = 0$, $0 \le x \le 1$ around the x-axis.

Solution: $3y - x^3 = 0$ or $y = \frac{1}{3}x^3$

$$y' = \left(\frac{1}{3}x^3\right)' = x^2$$

Let's use the formula $S = 2\pi\int_a^b f(x)\cdot\sqrt{1+[f'(x)]^2}\,dx$

$$Q_X = 2\pi\int_0^1 \frac{1}{3}x^3\cdot\sqrt{1+(x^2)^2}dx = \frac{2\pi}{3\cdot 4}\int_0^1 (1+x^4)^{\frac{1}{2}}d(1+x^4) =$$

$$= \frac{\pi}{6}\cdot\frac{2}{3}(1+x^4)^{\frac{3}{2}}\Big|_0^1 = \frac{2}{9}\pi(2^{\frac{3}{2}}-1) = \frac{2}{9}\pi(2\sqrt{2}-1).$$

Consider the same task in Maple

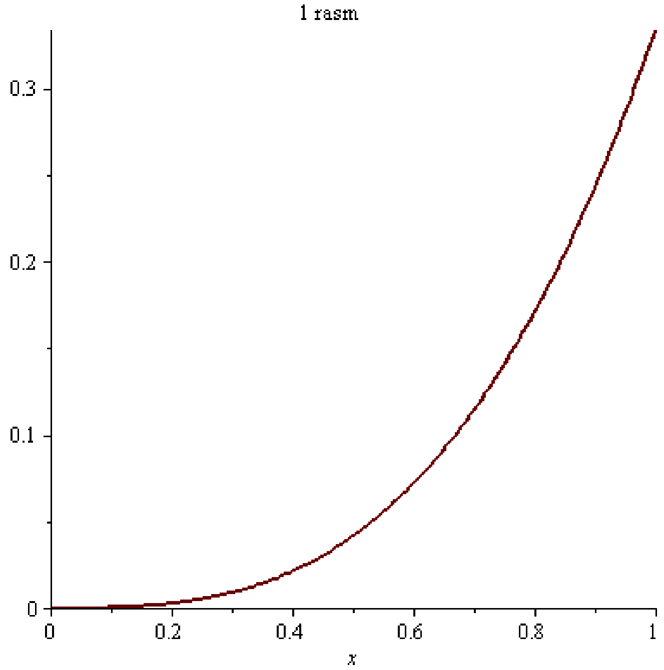
Example 44. Find the surface area of the figure obtained as a result of the rotation of the curve $3y - x^3 = 0$, $0 \le x \le 1$ around the x-axis.

Drawing with Maple.

> $restart : with(plots) : with(plottools) : y := x \to \frac{1}{3}x\verb|^|3 :$

> $F := plot(y(x), x = 0..1, thickness = 2) :$

> $plots[display]([F], scaling = unconstrained, title = \text{" 1 rasm"});$



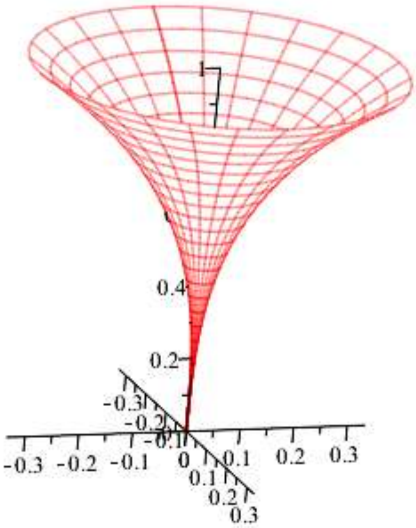
> $print(\text{`aylanma figurani chizamiz:`});$

aylanma figurani chizamiz:

> $F1 := plot3d\left(\frac{1}{3}h\verb|^|3, a = -\text{Pi}..\text{Pi}, h = 0..1, coords = cylindrical, axes = normal\right) :$

> $plots[display]([F1], scaling = unconstrained, style = hidden, title = \text{"2 rasm"});$

2 rasm



Finding the surface area in the maple program as follows

> *with*(*Student*[*Calculus1*]) :

> $IntTutor\left(2\cdot \mathrm{Pi}\cdot \frac{x^3}{3}\cdot\sqrt{1+(x^2)^2}\right)$

$$\int_0^1 \frac{2\pi x^3\sqrt{x^4+1}}{3}\,dx$$

$$= \frac{2\pi\left(\int_0^1 x^3\sqrt{x^4+1}\,dx\right)}{3} \qquad [constantmultiple]$$

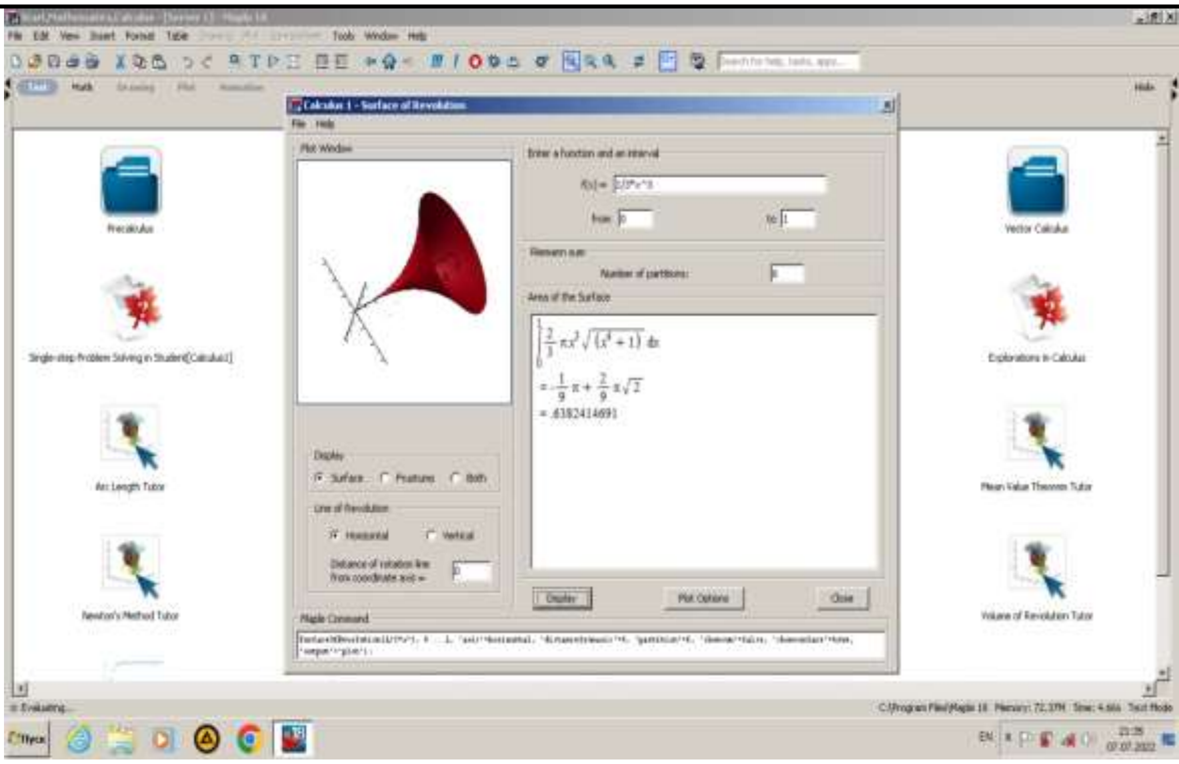
$$= \frac{2\pi\left(\int_1^{\sqrt{2}} \frac{u^2}{2}\,du\right)}{3} \qquad [change, x^4+1=u^2, u]$$

$$= \frac{\pi\left(\int_1^{\sqrt{2}} u^2\,du\right)}{3} \qquad [constantmultiple]$$

$$= \frac{2\pi\left(\frac{\sqrt{2}}{3}-\frac{1}{6}\right)}{3} \qquad [power]$$

$$\int_0^1 \frac{2}{3}\pi x^3\sqrt{x^4+1}\,dx = \frac{2}{3}\pi\left(\frac{1}{3}\sqrt{2}-\frac{1}{6}\right)$$

Or you can use the ready-made program



Conclusions:

Information technologies should be introduced in schools in the primary grades in the form of a game lesson, and more serious programs can be used already in the senior grades. So already when entering universities, students will have certain skills in using mathematical packages, which will make it easier to adapt to the educational process. This will improve the quality of education and increase student achievement in the subject.

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