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ISSUES OF EFFECTIVE ORGANIZATION OF PRACTICAL CLASSES AND CLUBS IN MATHEMATICS IN TECHNICAL UNIVERSITIES.

Rabimkul Abdunazarov
Senior Lecturer, Department of Applied Mathematics Jizzakh Branch of the National University of Uzbekistan, darobiz111@mail.ru

ISSUES OF EFFECTIVE ORGANIZATION OF PRACTICAL CLASSES AND CLUBS IN MATHEMATICS IN TECHNICAL UNIVERSITIES.

Abdunazarov Rabimkul

Senior Lecturer, Department of Applied Mathematics

Jizzakh Branch of the National University of Uzbekistan

E-mail address: darobiz111@mail.ru

Abstract: The article discusses the issues of enriching the assignments of practical classes and science clubs with educational materials in the field, depending on the direction of education. Building a mathematical model for undergraduate students to calculate the volume of liquid in a container with a complex appearance according to the given parameters, common in everyday life, based on this model, the problem of creating mobile applications, online calculators can be solved effectively using online websites for direct mathematical calculations.

The use of complex variable functions during problem solving increases students' ability to work with complex numbers.

Keywords: Mathematical model, online calculator, sphere segment, ellipsoid segment, elliptical paroboloid segment, elliptical cylinder, inverse hyperbolic functions, computational algorithm, convex surface, fluid volume, fluid level.

INTRODUCTION

As stated in the Resolution of the President of the Republic of Uzbekistan dated June 5, 2018 No PP-3775 "On comprehensive measures to improve the quality of education in higher education and the country", practical training to strengthen the theoretical knowledge of students and being able to choose assignments correctly in science circles is of great importance [1]. In particular, the selection of examples and problems in their field, acquaintance with the literature used to solve them, the possibilities of information and communication technologies, electronic information resources, as well as online web pages for direct mathematical calculations effectively affect the quality of lessons [2], [3] - [10].

Based on this, the following issue will be considered, which can be used in practical classes and clubs for students of technical universities.

MATERIALS AND METHODS

It is known that large-capacity cylindrical vessels with convex edges in the form of elliptical-based cones, ellipsoid (especially spherical, spheroidal), elliptical paroboloid segments are widely used in a wide range of populations and industries. In accurately calculating the volume of liquids in containers of this shape, it is necessary to use mainly guidelines and tables set by the manufacturer or the state standard. However, this guide may not be available at all times when needed. Therefore, there is a need to create mobile applications, online calculators that meet today's requirements, which provide this router-table information.

Therefore, this article discusses the construction of a model for calculating the volume of liquid in a complex-looking container according to the parameters given above, the creation of mobile applications, online calculators for professionals and the general public.

It is known that the solution of the problem cannot be found using elementary mathematical methods. During the solution of the problem, the student strengthens his knowledge of analytical geometry, inverse trigonometric functions with real and complex variables, arithmetic integrals, computational sequence - the construction of algorithms. You will gain a broad understanding of how to use online websites, programming technologies, and create mobile applications.

Basic information required for calculations:

h is the distance from the bottom of the vessel to the liquid level;

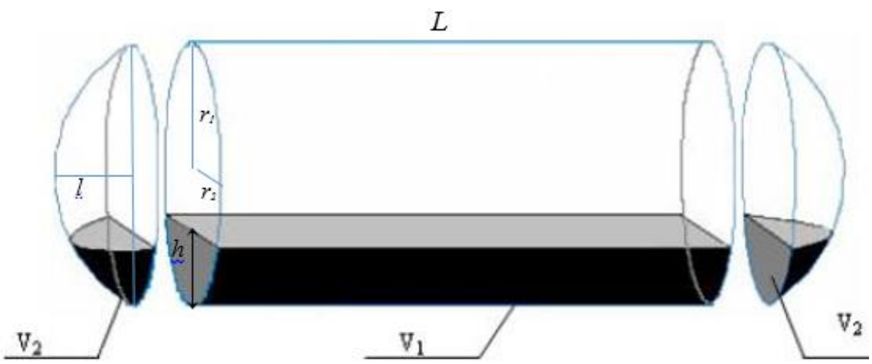
L is the length of the cylindrical part of the vessel;

r_1, r_2, - the lengths of the horizontal and vertical axes of the cross section of the cylinder (if the cross section is a circle r1 = r2 = r):

l is the length of the convex edge of the vessel, ie the distance from the end of the convex part of the vessel to the cylindrical part of the vessel (Figure 1).

RESULTS AND DISCUSSION

The article lists the formulas and calculation algorithms for calculating the volume of liquids in the container on the basis of the given necessary parameters, the literature on its use in solving the problem, a list of Internet resources [2] - [10].



(Figure 1)

1. Formulas for calculating the volume of liquid in an elliptical cylinder with non-convex edges [6].

1.1. When the container is in a horizontal position:

$$V_1(r_1, r_2, h_0) = r_1 r_2 \left(\arccos(h_0) + h_0 \sqrt{1-(h_0)^2} \right) L$$

1.2. When the container is in a vertical position:

$$V = \pi r_1 r_2 h$$

2. Formulas for calculating the volume of liquid in a cylindrical vessel with convex edges in the form of a spherical segment:

2.1. When the container is in a horizontal position:

$$V = 2V_2 + V_1(r, r, h_0),\ V_2 = -2\left(c^2 h - \frac{h^3}{3}\right) arccos\left(\frac{c-l}{\sqrt{c^2-h^2}}\right) -$$

$$-\frac{4c^2+2r^2}{3}(c-l)\, arccos\frac{h}{r} + \frac{4c^3}{3} arccos\frac{(c-l)h}{r\sqrt{c^2-h^2}} + \frac{2(c-l)h}{3}\sqrt{r^2-h^2}$$

2.2. When the container is in a vertical position:

The following is for the size of a sphere segment

$$v_1(h) = \pi h^2 \left(R - \frac{h}{3}\right),\ R = \frac{r^2+l^2}{2l}$$

the volume of liquid in the vertical container, given that the formula is appropriate

$$V=\begin{cases} v_1(h), & \text{агар } 0<h\le l \text{ бўлса,} \\ v_1(l)+\pi r^2(h-l), & \text{агар } l<h\le L+l \text{ бўлса,} \\ 2v_1(l)+\pi r^2 L - v_1(2l+L-h), & \text{агар } L+l<h\le L+2l \text{ бўлса} \end{cases}$$

is calculated using the formula [6].

3. Formulas for calculating the volume of liquid in a cylindrical vessel with convex edges in the form of an ellipse-based cone:

3.1 When the container is in a horizontal position:

$$V=\begin{cases} \frac{r_1 r_2}{3} l\left(\arccos h_0 - 2h_0\sqrt{1-h_0^2} - h_0^3 \ln\frac{1+\sqrt{1-h_0^2}}{h_0}\right)+V_1(r_1,r_2,h_0), \text{ агар } h\le r_2 \text{ бўлса} \\ \frac{r_1 r_2}{3} l\left(\pi - \arccos h_1 + 2h_1\sqrt{1-h_1^2} + h_1^3 \ln\frac{1+\sqrt{1-h_1^2}}{h_1}\right)+V_1(r_1,r_2,h_1), \text{ агар } r_2>h \text{ бўлса} \end{cases}$$

3.2. When the container is in a vertical position:

$$V=\begin{cases} \frac{\pi r_1 r_2}{3l^2}h^3 & \text{агар } 0<h\le l \text{ бўлса,} \\ \pi r_1 r_2 (h-\frac{2l}{3}) & \text{агар } l<h\le L+l \text{ бўлса,} \\ \frac{\pi r_1 r_2}{3l^2}\left[3Ll^2+2l^3+(2l+L-h)^3\right] & \text{агар } L+l<h\le L+2l \text{ бўлса} \end{cases}$$

4. The formula for calculating the volume of liquid in a cylindrical vessel with convex edges in the form of an ellipcoid segment:

4.1. When the container is in a horizontal position:

$$V=2V_2+V_1(r_1,r_2,h_0),$$

$$V_2=\frac{\sqrt{2al-l^2}}{2r_2^{\,2}}\left[-2\left(c^2h-\frac{h^3}{3}\right)arccos\left(\frac{b_1}{\sqrt{c^2-h^2}}\right)-\frac{4c^2+2r_2^{\,2}}{3}b_1 arccos\frac{h}{r_2}+\right.$$

$$\left.+\frac{4c^3}{3}arccos\frac{b_1 h}{r_2\sqrt{c^2-h^2}}+\frac{2b_1 h}{3}\sqrt{r_2^{\,2}-h^2}\right]$$

4.2. When the container is in a vertical position:

The following for the size of an ellipsoid segments

$$v_2(h)=\pi h\frac{\sqrt{2al-l^2}}{2r_2^{\,2}}\left(c^2-r_2^2+r_2h-h^2/3\right),\ v_3(h)=\pi h\frac{\sqrt{2al-l^2}}{2r_2^{\,2}}\left(c^2-h^2/3\right)$$

given that the formulas are appropriate, the volume of liquid in the container placed vertically using their appropriate combinations is as follows

$$V=\begin{cases} v_2(h), & \text{агар } h\le l \text{ бўлса}, \\ v_2(l)+\pi r_1 r_2(h-l), & \text{агар } l<h\le L+l \text{ бўлса}, \\ v_3(h-l-L)+v_2(l)+\pi r_1 r_2 L, & \text{агар } L+l<h\le L+2l \text{ бўлса} \end{cases}$$

can be calculated using the formula [5].

The variables a and c involved in the resulting formulas are actually the lengths of the horizontal and vertical axes of the ellipsoid, which are currently unknown variables. To find these unknowns, the following is done.

An ellipsoid under consideration

$$\left(\frac{x}{a}\right)^2+\left(\frac{y}{b}\right)^2+\left(\frac{z}{c}\right)^2=1 \qquad (1)$$

The basis of the convex segment is the surface formed by the transverse shear of the ellipsoid at the point x = a-l with respect to the x-axis, namely the axes r1, r2

$$\left(\frac{y}{r_1}\right)^2+\left(\frac{z}{r_2}\right)^2=1 \qquad (2)$$

is equal to the ellipse. In turn, by substituting the value x = a-l instead of x in equation (1), it follows that some elementary substitutions are performed

$$\frac{y^2}{(2al-l^2)\left(\frac{b}{a}\right)^2}+\frac{z^2}{(2al-l^2)\left(\frac{c}{a}\right)^2}=1 \qquad (3)$$

equality can be obtained. The resulting equations (2), (3) represent a single ellipse equation. Hence, the following between the lengths b, c and a by equating the corresponding denominators

$$b^2=\frac{r_1^{\,2}a^2}{2al-l^2}, \quad c^2=\frac{r_2^{\,2}a^2}{2al-l^2}, \quad b^2=\frac{r_1^{\,2}}{r_2^{\,2}}c^2 \qquad (4)$$

the relationship follows [4] -10].

It is clear from the last equations that another additional condition is required to determine the value of the lengths a, b, c. Depending on the practical aspects of the issue, one of the following cases can be chosen as an additional condition. For example,

1) If it is assumed that the convex surface consists of a spheroid segment formed by rotating an ellipse with vertical axis c and horizontal axis a around the z axis, then equation (4) gives the following for a, b, c.

$$a = b = \frac{{r_1}^2 + l^2}{2l}, \qquad c = \left(\frac{r_2}{r_1}\right)\frac{{r_1}^2 + l^2}{2l}$$

2) If the full volume of the container V_0 is known in advance

$$a = \left(\frac{3G - 1}{2G - 1}\right)\frac{l}{3}, \qquad G = \frac{V_0 - \pi r_1 r_2 L}{2\pi r_1 r_2 l}$$

Using the formula, we can find the length a and the lengths b, c, respectively, using equations (4). If one side of the vessel is not convex, the 2 coefficients in the denominator of the last formula are not involved.

5. The formula for calculating the volume of liquid in a vessel with convex edges in the form of an elliptical parabola segment:

5.1. When the container is in a horizontal position:

$$V = 2V_2 + V_1\left(r_1, r_2, h_0\right), \quad V_2 = \frac{r_1 r_2 l}{12}\left[3\arccos h_0 - (5 - 2h_0)h_0\sqrt{1 - h_0^2}\right] -$$

$$-\frac{r_1 r_2 l}{12}h_0^4\left[3Ln\frac{1 \pm \sqrt{1 - h_0^2}}{h_0} + \frac{1}{4}sh\left(4Ln\frac{1 \pm \sqrt{1 - h_0^2}}{h_0}\right) - sh\left(2Ln\frac{1 \pm \sqrt{1 - h_0^2}}{h_0}\right)\right]$$

5.2. When the container is placed vertically:

$$V = \begin{cases} \pi r_1 r_2 h^2 / (2l), & агар\, h \le l \ \text{бўлса}, \\ \pi r_1 r_2 l / 2 + \pi r_1 r_2 \left(h - l\right), & агар\, l < h \le L + l \ \text{бўлса}, \\ +\pi r_1 r_2 (l^2 - h^2)/(2l) + \pi r_1 r_2 L, & агар\, L + l < h \le L + 2l \ \text{бўлса} \end{cases}$$

can be calculated using the formula.

For convenience in calculations, the following

$$b_1 = \frac{c}{a}\left(a - l\right) = \left(\frac{r_2}{r_1}\right)\frac{r_1^2 - l^2}{2l}, \; h_0 = 1 - \frac{h}{r_2}, \; h_1 = \frac{h}{r_2} - 1, \quad c = \left(\frac{r_2}{r_1}\right)\frac{{r_1}^2 + l^2}{2l}$$

definitions are included.

Designed to find volumes when deriving formulas

$$V_{эллип.пароб.сег}(h) = \frac{2r_1 l}{3r_2^2}\left(\int_{r_2 - h}^{r_2}\left[\left(\sqrt{r_2^2 - z^2}\right)^{\frac{3}{2}} - \left(\sqrt{\left(r_2 - h\right)^2 - z^2}\right)^{\frac{3}{2}}\right]dz,\right)$$

$$V_{эллипс.сег}(h)=\frac{ab}{2c^2}\left(\int\limits_{r_2-h}^{r_2}\left(c^2-r^2\right)arccos\left(\frac{b_1}{\sqrt{c^2-r^2}}\right)dr-h\int\limits_{r_2-h}^{r_2}\sqrt{r_2^{\,2}-r^2}dr,\right)$$

$$V_{конус.сег}(h)=\frac{r_1 l}{2r_2^{\,2}}\left(\int\limits_{h}^{r_2}r^2arccos\left(\frac{h}{r}\right)dr-h\int\limits_{h}^{r_2}\sqrt{r^2-h^2}dr\right)$$

$$\arccos(ix)=\frac{\pi}{2}-\ln(x+\sqrt{1+x^2}),\qquad i\arcsin(ix)=\ln(x+\sqrt{1+x^2})$$

integral formulas, as well as the following ready-made integrals were used [2].

$$\int\sqrt{r^2-h^2}dr=\frac{r}{2}\sqrt{r^2-h^2}-\frac{h^2}{2}\ln\left(r+\sqrt{r^2-h^2}\right)+C,\quad \int\sqrt{h^2-r^2}dr=\frac{r}{2}\sqrt{r^2-h^2}+\frac{h^2}{2}\arcsin\left(\frac{h}{r}\right)+C$$

$$\int\frac{dx}{\left(R^2-x^2\right)\sqrt{r^2-x^2}}=\frac{1}{R\sqrt{R^2-r^2}}\arcsin\left(\frac{x\sqrt{R^2-r^2}}{r\sqrt{R^2-x^2}}\right)+C$$

CONCLUSION

Based on these calculation formulas, convenient-looking computing programs have been developed, interactive services have been set up on websites that can be used as online calculators, and mobile applications have been developed that can be used effectively in the training process. Most importantly, during the study of this study material, students learn to solve simple, multiple, surface integrals, as well as parametric integrals using special mathematical sites. Get acquainted with rich electronic libraries [6] - [10].

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