ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

Volume 10
Issue 2
2025

GRAPHICAL SOLUTION OF SYSTEMS OF EQUATIONS IN TWO-AND THREE-DIMENSIONAL SPACES USING MS EXCEL

UZOKOV FARXOD

PhD, Namangan State Technical University, Namangan, Uzbekistan
Phone.: (0894) 301-0181, E-mail.: farxodjonuzoqov@gmail.com

Abstract: In this article, methods for solving systems of equations using the graphical approach in MS Excel are presented. The theoretical foundations of the graphical solution method are explained, and the steps for using Excel functions are demonstrated step by step. As a practical example, systems of linear equations with two and three variables are analyzed, their graphs are constructed, and the point of intersection is determined.

Keywords: System of equations, equations in unknowns, argument, diagram, graphical method, linear equations, sinx, cosx, master function, mathematical modeling, point of intersection, two-dimensional, three-dimensional, spatial areas and Excel graphs.

Introduction. Solving a system of equations graphically

Systems of equations with two unknowns can be solved graphically. Their solutions are the coordinates of the points of intersection of the lines, which correspond to the system of equations. In this case, the accuracy of the solution is determined by the step of change (the smaller the step, the higher the accuracy).

Let's consider the graphical solution of a system of two equations.

An example: $\begin{cases} y = \sin x \\ y = \cos x \end{cases}$ system of equations x=[0(0,2)3] solve in the range.

Solution: To build a diagram, you need to enter the data into a worksheet. In cell A1, enter the word Argument, and in cell A2, enter the first value of the argument, i.e. 0. In subsequent cells, enter the argument, adding the step of change: A3-0,2. We enter the remaining values of the argument into the cells using autofill (select cells A2 and A3 and drag the mouse to the remaining cells, up to cell A17).

We need to enter the values of the sine function. To do this, we type sinus in cell B1 and place the cursor in B2. This cell should contain the first value of the sine function, which corresponds to the value in cell A2. To do this, click the Insert Function f_x button on the standard toolbar. In the Master function (step 1 of 2) dialog box that appears, the category field lists the type of functions (figure 1).

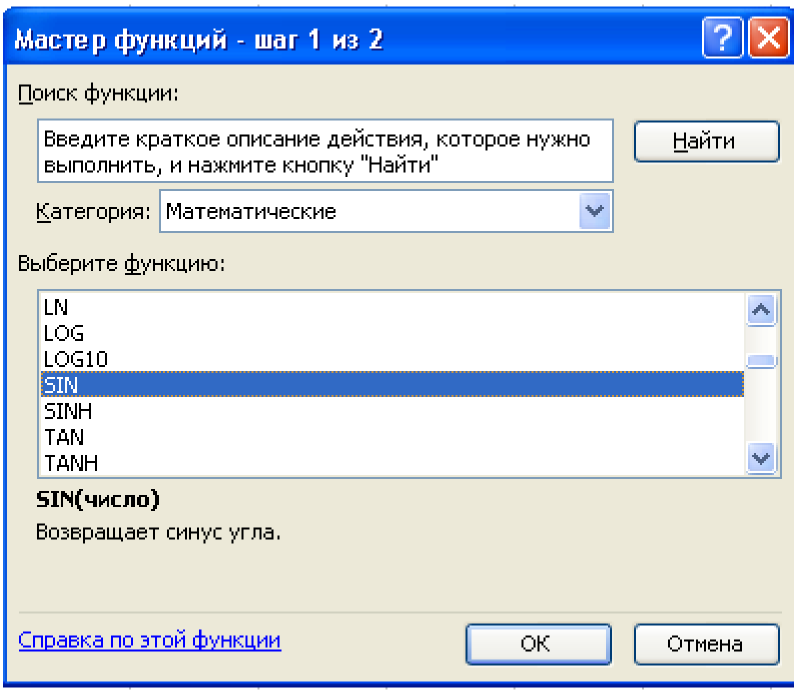


Figure 1. Selecting the function type in the Master Function dialog box

Select the mathematical type and in the Select function field, select the SIN function and click OK. We apply the function created in cell B2 to other cells in column B using autofill. Thus, the values of the sine function are determined.

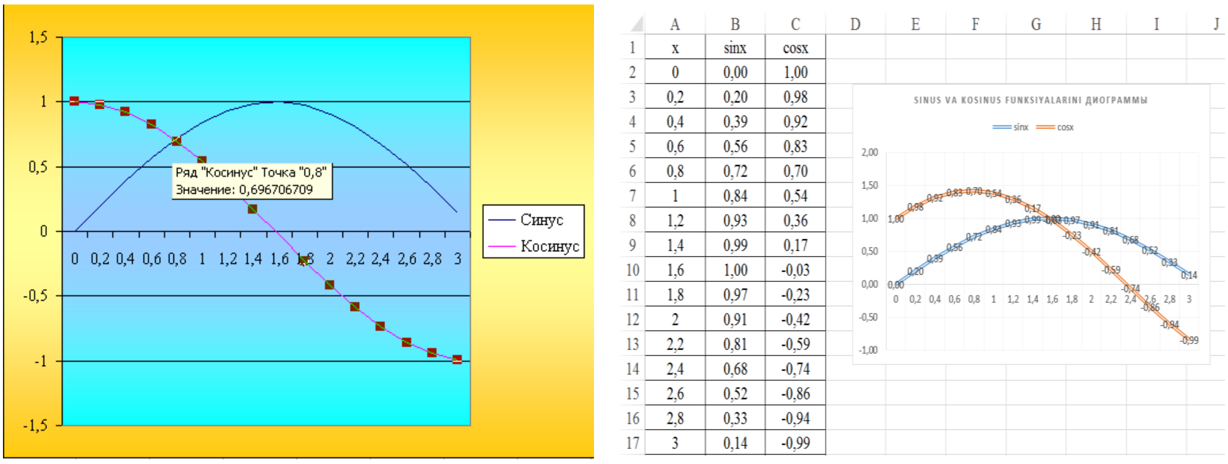
The values of the COS function are determined similarly to those of the sine function. In cell C1, enter the function name COS. Place the cursor in cell C2 and click the Insert function f_x button on the toolbar. In the master function dialog box that appears, select mathematical in the category field and COS in the Select Function field. The remaining cells in column C are filled using autofill.

The values of the Sin and Cos functions have been determined and now we can create a diagram.

On the toolbar, click the Master Diagram button and in the dialog box that appears, select the graph type (Type) Graph, in the view (View) section, select the upper left and click the Next button.

Diagram Master (step 2 of 4): Enter the data source dia… in the Range field - B2:C17, Rows in: columns are selected. Go to the Row section and in the Name: field corresponding to Row1, enter the words Sine, and in Row2 - Cos. In the X-axis label field, enter the range - A2:A17.

Click the Done button. The diagram of the sine and cosine functions is created (figure 2).



	A	B	C
1	x	sinx	cosx
2	0	0,00	1,00
3	0,2	0,20	0,98
4	0,4	0,39	0,92
5	0,6	0,56	0,83
6	0,8	0,72	0,70
7	1	0,84	0,54
8	1,2	0,93	0,36
9	1,4	0,99	0,17
10	1,6	1,00	-0,03
11	1,8	0,97	-0,23
12	2	0,91	-0,42
13	2,2	0,81	-0,59
14	2,4	0,68	-0,74
15	2,6	0,52	-0,86
16	2,8	0,33	-0,94
17	3	0,14	-0,99

Figure 2. Diagram of the system of equations

As can be seen from the diagram, the system has a solution and there is one point of intersection in the given range. The coordinates of the point of intersection of the lines indicate the solution of the system in the given range. To find them, you need to move the mouse pointer to the point of intersection and press the left button. The inscription of the determined coordinates will appear: Row "cosine", point "0.8", value: 0.696706709. Thus, the approximate solution of the system: x=0.8; u=0.697.

Example 2. The demand for a good y is given by the equation:

y=2/x + 2

The supply of a good z is given by the equation z=x2 + 1, given by the price of a good x. It is necessary to determine the equilibrium point in the range x=[0(0,2)3].

Solution: The equilibrium point is the intersection of the demand and supply lines. Before constructing these lines, it is necessary to enter x into the working area of the table. We enter the word Price in cell A1 and enter the data from cell A2 (using autofill).B1 yacheykaga so'rov kiritamiz va kursorni B2 yacheykaga joylashtiramiz. Uskunalar panelidan Мастер funksiy f_x knopkasini bosamiz.

To get the query value, we enter the equation y=2/x + 2 into the cell: =2/A2+2 and press Enter. We enter the values in the remaining cells of column B using autofill.

The word proposal is written in cell C1, the cursor is placed in cell C2 and the formula is written: =A2^2+1. The values in the remaining cells are filled in using autofill – C2:C16.

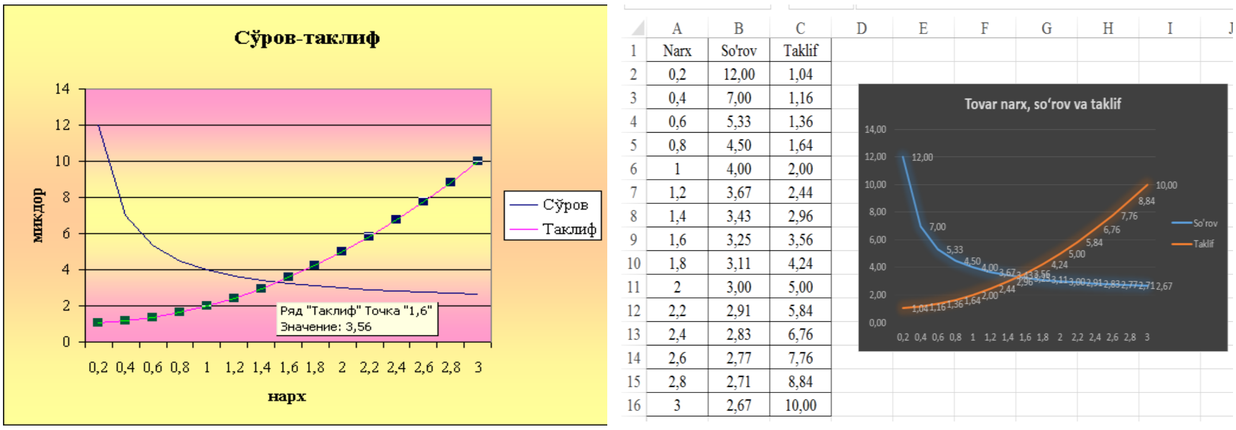
The data table is ready, now we will create a diagram. Click the Master Diagram button on the toolbar, select the diagram type (Type) Graphic, view (View) - top left, and click the Next button.

In the resulting dialog box, enter the Master Diagram (step 2 of 4): data source dia… B2:C16, select Rows B: in columns, go to the Row section: Row1 - query, Row2 - quotation marks, X-axis labels: A2-A16, and click the Next button.

Diagram Master (step 3 of 4): In the diagram parameters dialog box, select the Titles section and enter the following words: Request-offer; Os X (categories) - price; Os U (values) - quantity. In the Legend section, specify the Add legend.

Click the Done button.

The demand and supply line diagram is ready (Figure 3). The solution of the system in the given range is the coordinate of the intersection of the lines. To find it, move the mouse to the point of intersection of the lines and press the left button. The inscription that appears shows the required coordinates: Row "Offer" Point "1.6". Value: 3.56.



	A	B	C
1	Narx	So'rov	Taklif
2	0,2	12,00	1,04
3	0,4	7,00	1,16
4	0,6	5,33	1,36
5	0,8	4,50	1,64
6	1	4,00	2,00
7	1,2	3,67	2,44
8	1,4	3,43	2,96
9	1,6	3,25	3,56
10	1,8	3,11	4,24
11	2	3,00	5,00
12	2,2	2,91	5,84
13	2,4	2,83	6,76
14	2,6	2,77	7,76
15	2,8	2,71	8,84
16	3	2,67	10,00

Sectors in three-dimensional space

Any linear equation defines a plane, and conversely, any plane equation is a first-order equation.

$Ax + Vu + Sz + D = 0$

The equation in the form is called the general equation of the plane.

When some of the coefficients A, B, C, D are equal to 0, some cases of the equation of the plane arise.

1. The equation of the plane in the section:x/a + y/b + z/c =1

where a, b, c are the lines intersecting the coordinate axis, taking into account the sign.

2. The equation of the plane passing through a given point is:

$a(x-x_1)+b(y-y_1)+c(z-z_1)=0$

Equation of the plane M1(x1, y1, z1), M2(x2, y2, z2), M3(x3, y3, z3) passing through three points.

$$\begin{vmatrix} x-x_1 & y-y_1 & z-z_1 \\ x_2-x_1 & y_2-y_1 & z_2-z_1 \\ x_3-x_1 & y_3-y_1 & z_3-z_1 \end{vmatrix} = 0$$

Master diagrams in MS Excel can also be used to construct planes. The points of the plane are entered into the worksheet, the Master diagram is called, the diagram type is indicated, the data range, the x-axis label, and the names of the axes are entered.

Example. Let's consider constructing a plane using the equation 2x+4y-2z+2=0 as an example. We need to construct the part of the plane lying on the square I, and in this case x=[0(0,5)6], u=[0(1)6].

Solution. First, we need to solve the existing equation with respect to z:

$z=x+2y+1$

We enter the values of the variable x in column A of the table. To do this, we enter x in cell A1, the first value of the argument in A2, that is, 0. We enter the second value of the argument x in cell A3 - 0.5, and we form the rest using autofill.

We enter the values of the variable u in the 1st row. To do this, we enter the value 0 in cell B1, 1 in cell C1, and we form the rest using autofill (up to cell H1).

Now we need to enter the values of the variable z. In cell B2, we enter the equation for z: =$A2+2*B$1+1. It is worth noting that the $ symbols once indicate the column address (column A is the x variable), and twice indicate the row address (row 1 is the u variable). Then, using autofill, the formula is copied first to the range B2:H2, and then to cells B3:H14. As a result, the table shown in figure 4 is created.

	A	B	C	D	E	F	G	H
1	**x**	0	1	2	3	4	5	6
2	0	1	3	5	7	9	11	13
3	0,5	1,5	3,5	5,5	7,5	9,5	11,5	13,5
4	1	2	4	6	8	10	12	14
5	1,5	2,5	4,5	6,5	8,5	10,5	12,5	14,5
6	2	3	5	7	9	11	13	15
7	2,5	3,5	5,5	7,5	9,5	11,5	13,5	15,5
8	3	4	6	8	10	12	14	16
9	3,5	4,5	6,5	8,5	10,5	12,5	14,5	16,5
10	4	5	7	9	11	13	15	17
11	4,5	5,5	7,5	9,5	11,5	13,5	15,5	17,5
12	5	6	8	10	12	14	16	18
13	5,5	6,5	8,5	10,5	12,5	14,5	16,5	18,5
14	6	7	9	11	13	15	17	19

Figure 4. Preparing a table for the equation of a plane

On the Standard Tools toolbar, click the Chart Master button. In the Chart Master dialog box that appears (step 1 of 4), select the chart type Type: Plot and the view Type: Wireframe (transparent) plot and click Next. In the second dialog box that appears (Chart Master (step 2 of 4)), in the Range data section, in the Range field, specify the data range, i.e. B2:H14.

It is necessary to indicate where the data row is located in a row or column, which determines the x and y directions: Rows in: tables are selected.

The Row section is selected and the range of records along the x axis is displayed in the Labels Axis X field. To do this, the Labels Axis X field is activated by clicking on it and the x axis range is entered - A2:A14.

To enter the records of the U axis, the first record Row 1 is displayed in the Row workspace and the Name workspace is activated, the first value of the u variable, i.e. 0, is entered; Row 2 is the second value of the u variable, i.e. 1, and so on. In this way, all the values of the u variable are entered. As a result, the Row section will look like figure 5.

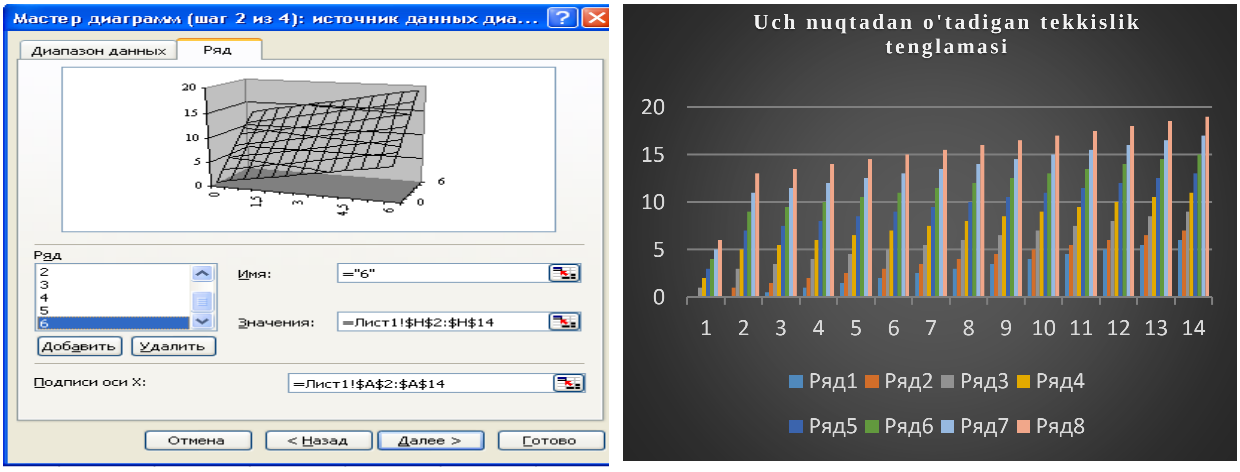


Figure 5. Example of filling in the Row section

After the necessary entries appear, click the Next button.

In the third dialog box, Master Diagram (step 3 of 4): the diagram parameters, the title and names of the axes should be entered. In the Titles section, enter "Plane", Os x (categories) - x, Os u (Data series) - y, Os z (values) - z.

Click the Done button and the diagram in Figure 6 will be created.

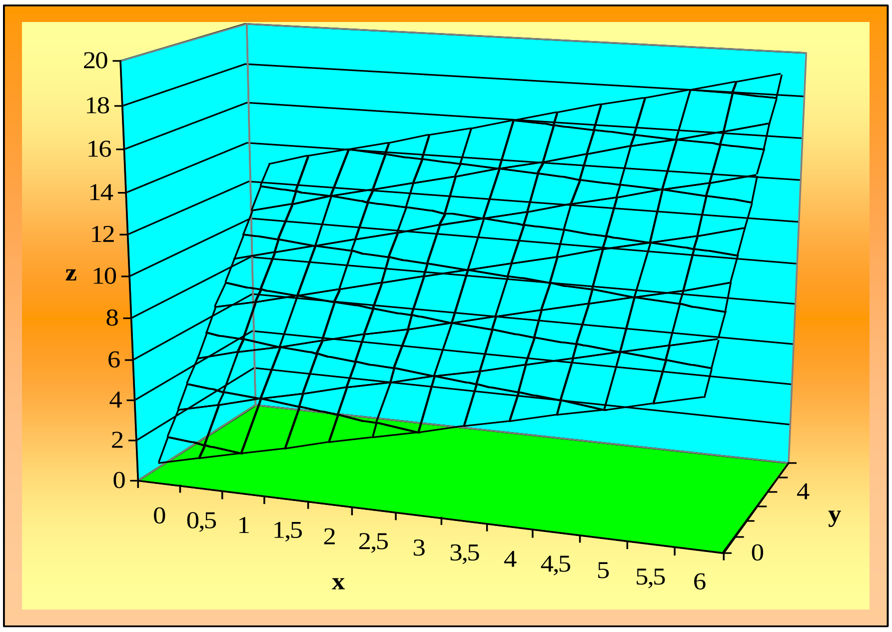


Fig. 6. Diagrams for the example of a plane

Second-order surfaces in space

The general equation of second-order surfaces has the form of the second equations:

$$Ax^2+By^2+Cz^2+2Dxy+2Eyz+2Fzx+2Gx+2Hy+2Kz+L=0 \qquad (1)$$

A, B, C, D, E, F cannot be equal to 0 at the same time.

The ellipsoid, hyperboloid, and paraboloid are basic second-order surfaces that form some solutions of equation (1).

Ellipsoid

An ellipsoid is a surface in a rectangular Cartesian coordinate system and is defined by the following equation:

$x^2/a^2 + y^2/b^2 + z^2/c^2 = 1$ (2)

This equation is called the canonical equation of the ellipsoid.

To construct an ellipsoid in Excel, you need to solve the canonical equation (2) with respect to the variable z (representing it in the form z=f(x, u)).

Example 1. $\frac{x^2}{9}+\frac{y^2}{4}+z^2=1$ Let's consider constructing an ellipsoid based on the given equation. The upper part of the ellipsoid is $x\in[-3;3], y\in[-2;2]$ in the range and the step change for both variables $\Delta = 0{,}5$ Let's consider the case when .

Solution. First, we need to solve the existing equation for the variable z.

$$z=\sqrt{1-\frac{x^2}{9}-\frac{y^2}{4}}.$$

Now we enter the values of the variable X in column A. In cell A2, the first value is entered: -3. In cell A3, the second value of the variable x, i.e. -2.5, is entered. We divide the two cells and use autofill to generate the remaining values of the argument (up to cell A14).

We enter the values of the variable in row 1. We enter -2 in cell B1, -1.5 in cell C1. We divide cells B1 and C1 and use autofill to determine the remaining values of the variable (up to cell J1).

We determine the values of the variable Z. Place the cursor in cell B2 and click the f_x-Insert Function button on the Standard Tools toolbar. In the Master Function dialog box that appears, select Mathematical in the Category field, and select the Root function in the Select Function field. In the working area of the Root dialog box, enter the expression under the root: *1-$A2^2/9-V$1^2/4*. OK button is pressed and #NUMBER! appears in cell B2 (x= -3 and u= -2 are not points of the ellipsoid in question). Using autofill, we copy the formula first to the range [B2:J2] (drag the mouse), then down to the range [V3:J14] and as a result we create the table in figure 7.

	A	B	C	D	E	F	G	H	I	J
1		-2	-1,5	-1	-0,5	0	0,5	1	1,5	2
2	-3	#ЧИСЛО!	#ЧИСЛО!	#ЧИСЛО!	#ЧИСЛО!	0	#ЧИСЛО!	#ЧИСЛО!	#ЧИСЛО!	#ЧИСЛО!
3	-2,5	#ЧИСЛО!	#ЧИСЛО!	0,235702	0,493007	0,552771	0,493007	0,235702	#ЧИСЛО!	#ЧИСЛО!
4	-2	#ЧИСЛО!	#ЧИСЛО!	0,552771	0,702179	0,745356	0,702179	0,552771	#ЧИСЛО!	#ЧИСЛО!
5	-1,5	#ЧИСЛО!	0,433013	0,707107	0,829156	0,866025	0,829156	0,707107	0,433013	#ЧИСЛО!
6	-1	#ЧИСЛО!	0,571305	0,799305	0,909059	0,942809	0,909059	0,799305	0,571305	#ЧИСЛО!
7	-0,5	#ЧИСЛО!	0,640095	0,849837	0,953794	0,986013	0,953794	0,849837	0,640095	#ЧИСЛО!
8	0	0	0,661438	0,866025	0,968246	1	0,968246	0,866025	0,661438	0
9	0,5	#ЧИСЛО!	0,640095	0,849837	0,953794	0,986013	0,953794	0,849837	0,640095	#ЧИСЛО!
10	1	#ЧИСЛО!	0,571305	0,799305	0,909059	0,942809	0,909059	0,799305	0,571305	#ЧИСЛО!
11	1,5	#ЧИСЛО!	0,433013	0,707107	0,829156	0,866025	0,829156	0,707107	0,433013	#ЧИСЛО!
12	2	#ЧИСЛО!	#ЧИСЛО!	0,552771	0,702179	0,745356	0,702179	0,552771	#ЧИСЛО!	#ЧИСЛО!
13	2,5	#ЧИСЛО!	#ЧИСЛО!	0,235702	0,493007	0,552771	0,493007	0,235702	#ЧИСЛО!	#ЧИСЛО!
14	3	#ЧИСЛО!	#ЧИСЛО!	#ЧИСЛО!	#ЧИСЛО!	0	#ЧИСЛО!	#ЧИСЛО!	#ЧИСЛО!	#ЧИСЛО!

Figure 7. Results of calculating the points of the ellipsoid

To build a diagram, click the Master Diagram button on the Standard Tools panel. The Master Diagram appears (step 1 of 4): Select the diagram type (Type) – Surface and appearance (View) – Wireframe (transparent) surface and click Next.

In the Chart Master (step 2 of 4): Data source dialog box, in the Range field, specify the data range [B2:J14]. It is necessary to specify whether it is located in columns or rows, select "Rows in: columns". Select the Row section, enter the range of the x-axis in "X-axis labels", and enter the values for the x-axis (similar to the example above), click Next.

Master Chart (step 3 of 4): After the Chart Options dialog box appears, we can enter the names of the chart axes. In the Diagram Name workspace, enter the Ellipsoid, X-axis (categories), Y-axis (data series), and Z-axis (values) x, u, and z. Select the Legend section, uncheck the "Add legend," and click the Done button. The ellipsoid shown in figure 8 is created.

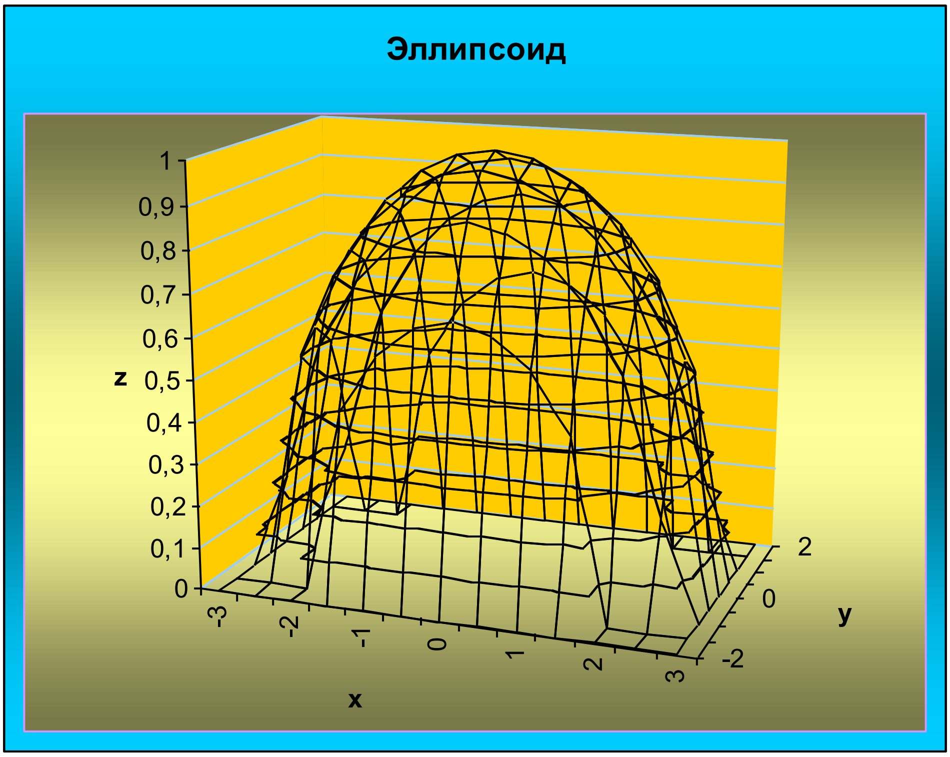


Figure 8. Upper part of the ellipsoid

References:

1. Raxmonqulova S.I. IBM PC shaxsiy kompyuterida ishlash.-Toshkent: Sharq, 1998.
2. Qosimov S.S. Kompyuter olami. Toshkent, 2001.
3. Xolmatov T.X. va boshq. Informatika va hisoblash texnikasi: Oliy o'quv yurtlarning talabalari uchun o'quv qo'llanma. –T.: O'zb-n milliy entsiklopediyasi, 2001.

CONTENTS

TECHNICAL SCIENCES: MECHANICS AND MECHANICAL ENGINEERING

ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION

ECONOMICAL SCIENCES