Sub-faculty of information technologies

COMPUTER SCIENCE
Module 1
The main data on a personal computer and about the organization of computing processes

Part 2

Methodical instructions for
laboratory and practical trainings

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The methodical instructions for laboratory and practical trainings contains a theoretical information on personal computers, Windows XP operating system, Microsoft Word text processor, and also short theoretical data and examples of projects in C ++ Builder for calculation of complex mathematical formulas and solving problems with branching. This text book contains eight laboratory works with control questions and individual problems. The text book will be useful to students who are studying in English, at fixing a theoretical material, preparation for laboratory and practical occupations on "Computer science" course in the first module.

It is intended for acquisition of skills of operation on a personal computer and programming by students of the academy, studying discipline "Computer science" in English, with the purpose of further usage of these skills in daily present and future professional work; also will be useful to users of the personal computers, wishing to learn programming in the C ++ Builder environment.

The text book is approved on sub-faculty IT meeting

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named after A.S. Popov meeting

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Contents

Introduction

C++ Builder is a popular development environment of applications for Windows operating system. The environment unites resources of the programming language C++ and the component-oriented approach to programs development. The combination of a visual development environment mastering simplicity and the broad spectrum of technologies support makes C++ Builder the universal tool of the applications development of any complexity level.

The text book contains a theoretical information on personal computers, Windows XP operating system, Microsoft Word text editor, short theoretical data and examples of projects in C ++ Builder for calculation of the complex mathematical formulas and solving the problems with branching, control questions and variants of the individual tasks. The text book will be useful to students who are studying in English, at fixing a theoretical material, preparation for laboratory and practical trainings on the "Computer science" course in the first module.

Each of the Laboratory works offered to execution has tasks of the different complexity levels. The student himself or under the teacher's instructions selects tasks of this or that complexity level according to a student's log number. At estimation of knowledge the teacher can consider a complexity level of the performed Laboratory work, an optimality of the made program algorithm, timeliness of preparation and performance of the task.

Before execution of the Laboratory work it is necessary for the student:

✓ to learn appropriate sections of the theoretical course according to the lecture notes and the educational literature;

✓ to describe an order of actions and prepare, if necessary, data for input (for Laboratory works 1−3);

✓ to make flowcharts of the task solution algorithm (for Laboratory works 5−8);

✓ to draw the form of the project and to make the table of its components property values (for Laboratory works 5−8);

✓ to write program code in C++ Builder (for Laboratory works 5−8);

✓ to prepare the report of Laboratory work performance and show it to the teacher for the check.

The student having the self-prepared report is admitted to Laboratory assignment execution.

Contents of Laboratory work report:

✓ the theme and the purpose of the Laboratory work;

✓ a summary of the main theoretical positions;

✓ answers to the control questions;

✓ charts of algorithms for solution of the individual task;

✓ the form of the project and the table of its components property values;

✓ code of the programs in C++ Builder;

✓ results of calculations on a computer.

Structure of module 1

The discipline "Computer science" is studied in I - II semesters and intended for training students to operation on a personal computer to use it in their professional work.

The course program consists of four modules:

- module 1 – "The main data on a personal computer and about the organization of computing processes";
- module 2 – "Programming of tasks with loops and arrays";
- module 3 – "Programming of tasks with the structured data";
- module 4 – "Programming of tasks with lists and files. Bases of object oriented programming".

The purpose of the Computer science course is to form knowledge and skills in areas such as:

- architecture of a personal computer
- operation in Windows operating system
- algorithmization of computing processes
- compilation of programs on C ++ programming language
- acquaintance to object oriented programming on an example of solution of the elementary tasks in C ++ Builder programming environment.

According to the curriculum, the structure of the module is as following:

Type of activity	Hours
Lectures	8
Exercises	8
Laboratory Training	16
Total Classwork Hours	32
Individual Work and Self-study	40
TOTAL	72

Laboratory work 1.1 Acquaintance to Microsoft Windows

The purpose is to get the acquaintance with the main operations with files and folders in Microsoft Windows.

1.1 Control questions

1. What are the five main components of a computer system?
   a. CPU, CD-ROM, mouse, keyboard, sound card
   b. Memory, video card, monitor, software, hardware
   c. Modem, keyboard, Word processor, printer, screen
   d. CPU, memory, system bus, input, output
2. How do the main components of the computer communicate with each other?
   a. system bus
   b. memory
   c. keyboard
   d. monitor
3. What are the tasks carried out by the Central Processing Unit?
4. What are the major differences between the main memory and the external memory?
5. What is "byte"?
6. How information is represented inside the computer systems?
7. Icons of what Windows objects are located on the Desktop of your computer?
8. Icons of what objects are located on the Taskbar?
9. What are the basic functions of the "Start" button?
10. What regions does the main menu window ("Start" button) consist of?
11. For execution of what functions command "Shut down" of main menu is intended?
12. What functions does the "My computer" icon carry out?
13. Describe your actions to:
   a. run the file;
   b. copy a file from one folder to another;
   c. move a file from one folder to another;
   d. create a text file;
   e. delete a file;
   f. rename a file;
   g. select a group of files;
   h. find a file with name *yest.doc* if we know that it is somewhere in drive D:;
   i. save the file contents;
   j. edit the file created earlier;
   k. save the file in other folder or with other name.

1.2 Creation of your own folder

1. Right-click on the **My computer** icon. Select **Explorer** from the menu.
2. Enter the folders **My documents**, then **1_kurs**, then **1_semestr**.
3. In the **File** menu select **Create**. In the Explorer right panel in the current directory there will be a tag with the signature "New folder". Change this inscription to the folder's name (your group – for example, TE-1.1).
4. Enter the created folder (double-click it or point it and then press the Enter-key).
5. Now it is necessary to create your second folder. Its name is your surname. Do it similarly as 4 or more quickly:
   - Right-click on the opened area in the Explorer's right panel (when you are in your group's folder).
   - Select **New** – **Folder** in the context menu.
   - Type your surname instead of "New folder" and press the Enter-key.
6. Close the Explorer window.

1.3 Creation of the text with Notepad

1. Open the Notepad text editor. For this purpose click the Start button. Select **Programs** – **Accessories** in the opened menu. Then click **Notepad**. The Notepad text editor will open.
2. Press **F5** key to place time and date. Then type your surname, name and second name. Press F5 once more and then type your organization, address and other information about yourself. Save this file with the name "Information+your surname" (use **File** – **Save**).
3. Close Notepad.

1.4 Manipulations with your file and shortcut to it

1. Find your file "Information+Surname". Right-click on your folder. Left-click **Find** – **Files and Folders**. Enter the file name in the appeared window and click button Find.
2. Run the file and save it in your folder (**File** – **Save as**).
3. Create a **shortcut** to your file in your group folder. Open the Explorer window. Drag your file's icon on your group's folder with the right mouse button and select **Create shortcut**.
4. Enter your group's folder. There is the shortcut to your file.
5. Run your file from the shortcut. Close your file.
6. Delete your shortcut from the group's folder (right-click on the shortcut, then select **Delete**). Check that your file in your folder is not deleted.
7. Copy your file to your group's folder. Then delete it.
8. Find files with the *jpg* extension in your computer. Right-click on the **My computer** icon, then **Find** – **Files and Folders** and type the name **.jpg* (* instead of the unknown name) and click **Find**. Copy three of the founded files into your folder.
9. Create a new folder Lab1 in your folder and move all your files into it.

Laboratory work 1.2 Acquaintance to Microsoft Word text processor

The purpose is to get the acquaintance with the main operations with text in Microsoft Word text processor.

2.1 Control questions

1. What are the elements of the Word text-editor window?
2. What are the purposes and structure of the "Standard" toolbar?
3. What are the purposes and structure of the "Formatting" toolbar?
4. Describe your actions to:
   a. change the text *font*, *size* and *color*;
   b. make the text *bold* or *italic*;
   c. underline your text with the bold line;
   d. align the text on the center;
   e. make the double line spacing;
   f. insert Greek letters in your document;
   g. insert a picture in your document;
   h. copy fragment of the text into other place;
   i. move fragment of the text into other place;
   j. change one letter in the typed text;
   k. insert a word in your text;
   l. delete fragment of the text;
   m. start a new page;
   n. insert a picture in your document.
5. What is "Wrapping style"?
6. You want to call attention to a list of items in a document by making a bulleted list. Which menu do you select?
7. The bullets you placed in #6 are too plain, you want to change them. Which menu do you select?
8. A word in the title of a sign does not look right and you want to change the spacing between the letters. Which menu do you select?
9. To make a document fit on one page you need to adjust the page margins. Which menu do you select?
10. You want to change the font on a document to Helvetica. Which menu do you select?
11. You want to make the fragment of the text bold. How can you do it?

2.2 Creation and edition the text in Word

1. Open Microsoft Word text processor (click **Start** – **Programs** – **Microsoft Word**).

2. Type the following text (don't mention the border). Do not press Enter key at the end of each line if it is not necessary. Format this text according to the table 2.1 (use **Format** – **Font** and **Format** – **Paragraph** or click the correspondent buttons on the toolbars).

After this your text will look like:

Microsoft Word Tutorials

What makes these Microsoft Word tutorials different to every other Microsoft Word tutorial?

The creators of other Microsoft Word tutorials think it's OK for you to wade through masses of text, to work out for yourself what you should learn next and to leave you with lots of unanswered questions. It's NOT OK

Nail It Now Microsoft Word tutorials are unique

You don't have to think, read masses of text or work anything out for

yourself

You blindly follow the steps, obediently clicking this tool, that command, this color box,

that square, not having a clue what you are doing

And, when you finish,

"Wow, look what I did . . . it's SO easy"

You learn more in 15 minutes than hours wading through
other Microsoft Word tutorials

"I had to e-mail you in the middle of my new Microsoft Word tutorial to tell you how terrific it is and how much fun I am having. You are so clever. An "idiot" could follow your directions. How did you ever manage to design this wonderful aide? It is instructional AND fun all at the same time"

Barbara Friedman
Baltimore, Maryland USA

Table 2.1 Information about format

Lines	Font	Size	Alignment	Tracing	Color	Underline	Line spacing
1	Times New Roman	18	center	bold	blue	double	double
2	Arial	12	left	bold	black	single	one-and-a-half
3-5	Courier New	12	justified		black	wave	one-and-a-half
6	Times New Roman	12	center	bold	black	-	double
7	Arial	14	center	bold	blue	-	double
8-10	Verdana	10	center	bold	black	-	double
11	Arial	14	center	bold	brown	-	double
12-13	Times New Roman	12	center	bold/-	black	-	single
14-16	Verdana	10	justified	italic	black	-	single
17-18	Times New Roman	10	right		black	-	single

3. Save the text in your folder with the name "tutorial.doc".

4. Copy lines 3-5 five times on the second page. To do this highlight the text to copy. Then press **Ctr+C** to remember this text. Set the cursor after the end of the text on the first page and press **Ctrl+Enter**. You will jump to the second page. 5 times press **Ctrl+V** to paste the text.

5. Close Word.

2.3 Check whether your file is in your folder

1. Run **Explorer** as earlier or click **Start – Programs – Accessories – Explorer**.

2. Find the disk **C:** in the left panel of the Explorer window. Then find and enter **My Documents** folder and so on until you enter your folder.

3. There will be your file **tutorial.doc** in the right panel. It has an icon of MSWord.

4. Call your file (double-click).

2.4 Add Bullets and Numbering and the picture to your document

1. Add the following text with bullets and numbering on the third page of your document. Use **Format – Bullets and Numbering**. Click **Customize** button to customize the Bullets character.

2. Format the text, insert the picture (**Insert – Picture – Clip Art**) and place it as shown below (right-click on the picture, then **Format Picture** and **Layout** tabs, select **Wrapping style – Square**).

I know the following **operating systems**:

1) Microsoft Windows
2) Unix
3) Linux
4) OS/2
5) Microsoft DOS
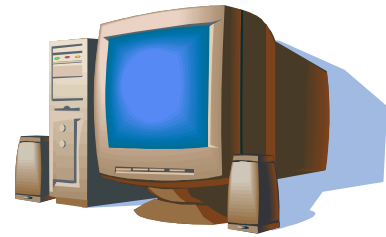
Microsoft Office consists of the following components:

- **Microsoft Word** provides powerful tools for creating and sharing professional word processing documents.
- With **Microsoft Excel** you can create detailed spreadsheets for viewing and collaboration.
- **Microsoft Access** gives you powerful new tools for managing your databases.
- **Microsoft PowerPoint** provides a complete set of tools for creating powerful presentations.
- **Microsoft Publisher** helps you easily create, customize, and publish materials such as newsletters, brochures, flyers, catalogs, and Web sites.

2.5 Add the call timetable and replace a word

1. Add the call timetable on the fourth page of your document as shown below. Use tabs (**Format – Tabs**) and the superscript (**Format – Font**).

To make tabs with dots place cursor after **I**, then go to **Format – Tabs**, write the **Tab stop position** (position of number 8, in this example it is 3 cm), and select **Leader** (2 – dots). Click Set and OK. Then press Tabs key ⮂.

To write 8^{00} you can at first type 800. Then highlight 00 and go to the **Format – Font**. Then mark the **Superscript** item and click OK.

I ....$8^{00} - 9^{20}$
II.........$9^{45} - 11^{05}$
III ....$11^{30} - 12^{50}$
IV ....$13^{15} - 14^{35}$
V ....$15^{00} - 16^{20}$

2. Find and replace all words "Microsoft" with "MS" in your document (use **Edit – Replace**).

2.6 Change the page setup and create a header

1. Insert the page numbers in the bottom-center of the page (go to **Insert** – **Page Numbers**).

2. Set the following figures for the page margins (**File** – **Page Setup**)

Top	2. 5 cm
Bottom	2. 5 cm
Left	3 cm
Right	2. 5 cm

3. Create a **header**. In the **View** menu, click **Header and Footer**. Type your surname and name inside the heading area and insert the current date from the Header and Footer toolbar. Then click somewhere in your document to return there.

4. Create the folder **Lab2** in your folder. Save your file in Lab2 folder (use **File** – **Save As**…).

2.7 The table of contents creation

1. On the top of the first page type: Task1. Set **style** Heading 1 for this text. On the top of the second page type: Task 2 and set the style again Heading 1. Do the same with other pages.

2. On the fifth page type: "The Table of Contents". Place the cursor on the next line and go to **Insert – Reference – Index and Tables**. Click on the **Table of Contents** tab. Set your parameters and click OK.

3. Save your document.

Laboratory work 1.3 Operating with tables and formula creation in MSWord editor

The purpose is to get the acquaintance with the main operations with tables in the Microsoft Word text processor and to study the Microsoft Equation formula editor.

3.1 Control questions

1. How can we insert a new table in the document (give all possible ways)?
2. How can we add a column in the table between the second and the third columns?
3. How can we delete the second row from the table?
4. How can we resize the first column of the table (two ways)?
5. How can we change the border color in the table (two ways)?
6. How can we sort data in the table?
7. How can we merge cells?
8. How can we calculate the sum of the column values?
9. How can we transform table into text and text into table?
10. How can we write the math formula in the document?
11. How can we edit the formula created earlier?

3.2 The theoretical information

3.2.1 Tables

Tables are used to display data and there are several ways to build them in Word. Begin by placing the cursor where you want the table to appear in the document and choose one of the methods. The most common method is: select **Table – Insert – Table** from the menu bar. Select the number of rows and columns for the table and click OK.

One block in a table is called a **cell**.

Inserting Rows and Columns

Once the table is drawn, insert additional rows by placing the cursor in the row you want to be adjacent to. Select **Table – Insert - Rows Above** or **Rows Below**. Or, select an entire row and right-click with the mouse. Choose **Insert Rows** from the shortcut menu.

Much like inserting a row, add a new column by placing the cursor in a cell adjacent to where the new column will be added. Select **Table – Insert – Columns to the Left** or **Columns to the Right**. Or, select the column, right-click with the mouse, and select **Insert Columns**.

Tables and Borders Toolbar

The Tables and Borders toolbar allows you to add border styles, shading, text effects, alignment, and more options to your table. Access the toolbar by clicking **View – Toolbars – Tables and Borders**.

You will need to highlight the cells of the table you want to format. Click and drag the mouse over the cells, or use the following shortcuts (table 3.1):

Table 3.1 Shortcuts for selection cells

Selection	Menu Method	Mouse Method
One cell	**Table – Select – Cell**	Click the bottom-left corner of the cell when a black arrow appears
One row	**Table – Select – Row**	Click outside the table to the left of the row
One column	**Table – Select – Column**	Click outside the table above the column when a black arrow appears
Several rows	**(none)**	Click outside the table to the left of the row and drag the mouse down
Several columns	**(none)**	Click outside the table above the column
Entire table	**Table – Select – Table**	Triple-click to the left of the table

Table Properties

Use the **Table Properties** dialog box to modify the alignment of the table with the body text and the text within the table. Access the box by selecting **Tables – Table Properties**.

- **Size** – check the **Preferred width** box and enter a value if the table should be an exact width.
- **Alignment** – highlight the illustration that represents the alignment of the table in relation to the text of the document.
- **Text wrapping** – highlight "None" if the table should appear on a separate line from the text or choose "Around" if the text should wrap around the table.
- **Borders and Shading** – select from a number of border styles, colors, and widths. Click the **Shading** tab to change the background color and pattern.
- **Options** – click the **Options** button on the **Table Properties** window. To change the spacing between the document text and the table borders

Fig. 3.1 Table properties window

under **Default cell margins**. Check the **Allow spacing between cells** box and enter a value to add space between the table cells.
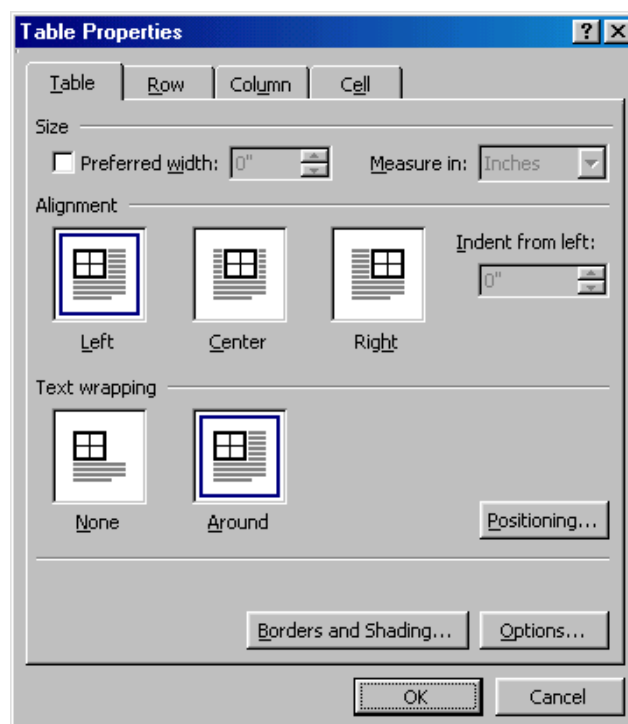
Resizing the column width

You can resize the column width by placing the cursor on the line that separates two columns. This causes the width indicator to appear. After the width indicator appears, left-click and drag with the mouse to adjust the column width (fig. 3.2).

Sorting data

With Microsoft Word, it is easy to sort the data in the table. To sort the table data by one of the fields:

1. Click anywhere on your table.
2. Choose **Table – Sort** from the menu.
3. Select field in the **Sort By** field.
4. Select Text or Number or Date in the **Type** field.
5. Select **Ascending** or **Descending** order.
6. Select **Header Row** (if your table has titles across the top of the table).
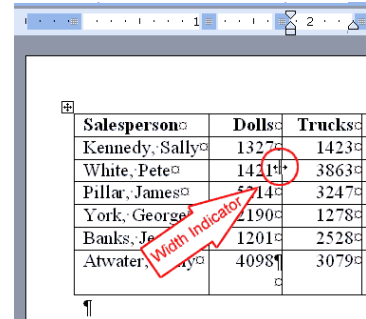7. Click OK.

Fig. 3.2 Resizing width of the column Dolls

Deleting a Column or a Row

You can delete columns from the table.

1. Place your cursor anywhere in the column (or row) you want to delete.
2. Choose **Table – Delete – Columns** (or **Rows**) from the menu.

Merge Cell

Using Microsoft Word, you can merge cells – turn two or more cells into one cell. Select cells you want to merge and choose **Table – Merge Cells** from the menu.

Table AutoFormat

You can use AutoFormats to apply borders, shading, special fonts, and color to the table. Microsoft Word lists all Formats in the **Table AutoFormat** dialog box. In the Table AutoFormat dialog box, click a format to see that format displayed in the Preview box. You can customize how the format is applied. Check the features you want in the Formats to Apply and the Apply Special Formats To frames.

Charts

To insert the chart in your document do the following:

1 Select **Insert – Picture – Chart**.

2 A chart and a spreadsheet will appear in your document. You can modify the information displayed in the chart by modifying the data in the Datasheet view (just copy correspondent data from your table).

3 To edit the created chart simply double-click on it.

3.2.2 Microsoft Equation Editor

To insert formula in the document:
1 On the **Insert** menu, click **Object**.
2 In the **Insert Object** dialog box, select **Microsoft Equation 3.0**.

Equation Editor will insert a blank working area into the document, and the **Equation** toolbar and menus will appear within the Office program's window. The formula you insert is an embedded object created by the Equation Editor program.

Use the following instructions to create a mathematical expression:

1. To enter numbers or variables, simply type them using the keyboard, such as the *y* typed to begin the following example equation:

$$y|$$

2. To enter a mathematical operator that appears on the keyboard, such as the plus sign (+), the minus sign (–), or the equals sign (=), you can simply type it. For instance, you could add an equals sign to the example equation, as shown here:

$$y =$$

3. To enter an operator or symbol that doesn't appear on the keyboard, click the appropriate button on the top row of the Equation toolbar and then click the desired symbol on the drop-down menu of symbols. For example, clicking the symbol shown in fig 3.3:
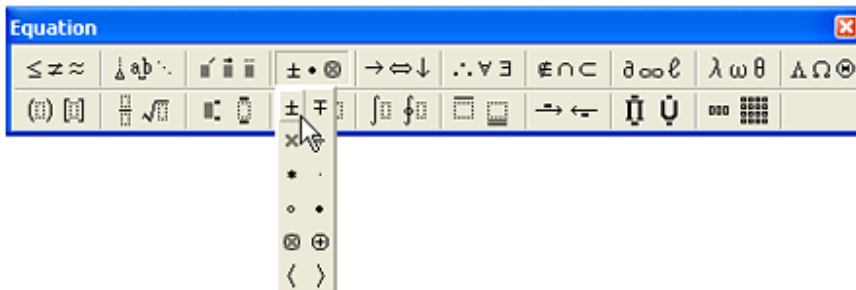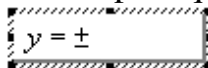
Fig. 3.3 Microsoft Equation toolbar (± symbol selected)

adds a plus-or-minus symbol (±) to the example equation, as shown below:

$$y = \pm$$

4. To enter an expression such as a fraction, a square root, an exponent, or an integral, click the appropriate button on the bottom row of the Equation toolbar, and then click one of the templates on the drop-down menu. For example, click the following template to add a square-root expression to the example equation, as shown below:
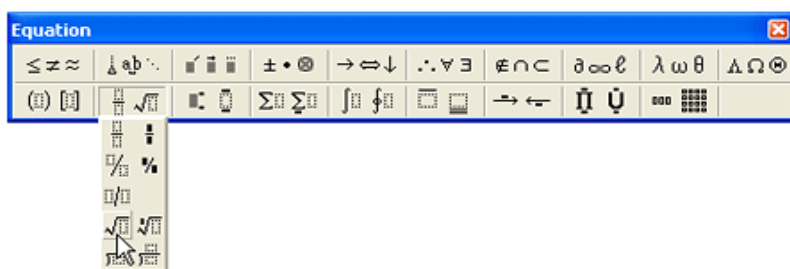
Fig. 3.5 Microsoft Equation toolbar ($\sqrt{}$ symbol selected)

5. Enter the desired numbers and variables into the area marked by the dotted lines within the template. For example, you could type the following into the radical expression in the example equation:

3.3 Individual task

1. Prepare a table with data (5 rows), according to your individual task (look at the table 3.3) in your report. The template of the table format is shown in the table 3.2:

Table 3.2 Template of the table format

A header of the table					
№	*Field 1*	*Field 2*	*Field 3*	*Field 4*	*Field 5*
…	…	…	…	…	…
…	…	…	…	…	…

2. Create the same table in MS Word (Table – Insert Table, 7 rows and 6 columns).
3. Merge cells to write the header and set borders and shading as in the template.
4. Format the text in your table as in the template (header – size 20, bold, underlined; field headers – size 16, bold, italic; other cells – size 14).
5. Create a diagram according to the table's data (Insert – Picture – Chart).
6. Sort the data in your table according to the individual task (table 3.4)

Table 3.3 Variants of individual tasks for table's header and field names

Var. №	Header	Field 1	Field 2	Field 3	Field 4	Field 5
1...4	Arrival of books to library	Author	Name of the book	Quantity of pages	Year of issuing	Price
5...8	Waybill of orders registration	Surname of the customer	Name of the goods	Quantity	The order date	Price

Continuation of Table 3.3 Variants of individual tasks for table's header and field names

Var. №	Header	Field 1	Field 2	Field 3	Field 4	Field 5
9...12	Paysheet	Surname	Position	Category	Salary	Log number
13...16	Biographical particulars of employees	Surname	Position	Date of employment	Rating	Year of birth
17...20	Range of goods in a warehouse	Name of the goods	Date of arrival	Quantity	Price	Date of output
21...24	List of APS abonents	Phone number	Surname	Privilege codes (0-4)	Debt	Address
25...28	List of enterprises	Name of enterprise	Volume of released production	Profit for a year	Surname of the head	Phone (fax)
29...30	List of disks	Code	Name of a disk	Quantity of songs	Time of sounding	Price

Table 3.4 Variants of individual tasks for sorting

Variants	Field number for sorting	Sorting order
1...4	4	ascending
5...8	3	descending
9...12	5	ascending
13...16	4	ascending
17...20	2	descending
21...24	4	descending
25...28	3	ascending
29...30	5	descending

7. Write the following formula in your document:

a) For even variants $Shi(x) = \int\limits_0^x \frac{sht}{t}\, dt$;

b) For not even variants $Chi\ (x) = \gamma + \ln(x) + \int\limits_0^x \frac{cht - 1}{t}\, dt$.

8. Write the given formula using Microsoft Equations and add the comment to formula according to your individual task (table 3.5).

Table 3.5 Variants of individual tasks (formulas)

Variants	Formula	Variants	Formula
1,2	$y = \prod_{i=1}^{n} \dfrac{x_i}{\sum_{k=1}^{i}(1+\beta_k)}$	3,4	$y = \dfrac{\sum_{i=1}^{n}(\alpha_i + \beta_i)}{\sum_{i=1}^{n}(1+x_i)}$
5,6	$y = \dfrac{\prod_{i=1}^{n}(1+ln|x_i|)}{\sum_{i=1}^{n} i \cdot \alpha_i}$	7,8	$y = \sum_{i=1}^{n} \dfrac{x_i^2}{\prod_{k=1}^{i}(1+|\beta_k|)}$
9,10	$y = \prod_{i=1}^{n}\left(1+\dfrac{x_i}{\sum_{k=1}^{i}\alpha_k}\right)$	11,12	$y = \sum_{i=1}^{n} \dfrac{1+\prod_{k=1}^{i}x_k}{1+|\gamma_i|}$
13,14	$y = \dfrac{1}{n}\sum_{i=1}^{n}\dfrac{x_i + 0,5}{\prod_{k=1}^{i}\beta_k}$	15,16	$y = \prod_{i=1}^{n}\dfrac{\sum_{k=1}^{i}\gamma_k}{|x_i - 7,3|}$
17,18	$y = \sum_{i=1}^{n}\dfrac{\prod_{k=1}^{i}x_k}{\alpha_i^3 - \beta_i^2}$	19,20	$y = 4 \cdot ln\left|\sum_{i=1}^{n}\dfrac{x_i - 2,5}{\prod_{k=1}^{i}1+\gamma_k^2}\right|$
21,22	$y = \sqrt{\dfrac{\sum_{i=1}^{n}x_i^2}{\prod_{i=1}^{n}\alpha_i^2 \cdot \beta_i^3}}$	23,24	$y = \sqrt{\dfrac{\sum_{i=1}^{n}(\alpha+\gamma)^2}{ln\left|\prod_{i=1}^{n}x_i\right|}}$
25,26	$y = tg\sum_{i=1}^{n}\dfrac{\prod_{k=1}^{n}x_k}{\gamma_i^3 + 7,2 \cdot x}$	27,28	$y = ln\left|5 - \sum_{i=1}^{n}\dfrac{\prod_{k=1}^{i}x_k}{(1+\beta_i^3)}\right|$
29,30	$y = \sum_{i=1}^{n}\dfrac{x_i^3 - 2 \cdot x_i}{\prod_{k=1}^{i}(1+\gamma_k)}$	31,32	$y = \dfrac{cos\left(\prod_{i=1}^{n}x_i\right)}{sin\sum_{i=1}^{n}(\alpha_i^3 - \beta_i^2)}$

Laboratory work 1.4 Acquaintance to Borland C++ Builder IDE

The purpose is to get skills of debugging programs in C++ Builder IDE and to get acquainted with the main components and the interface.

4.1 Control questions

1. What is a program?
2. What files does a new project automatically contain?
3. How can we create a new project?
4. Describe your actions to:
    a. save the project in your folder;
    b. place components on the form;
    c. change the Caption property of the Button;
    d. delete contents of the Edit Box.
5. What is an event's handler?
6. How can we create event's handler function?
7. How can we toggle between the Form and the Code Editor window?
8. What is compilation?
9. How can we run the project?

4.2 Theory information

A program is a set of instructions for computer. Each program must be written on a special language, which is called programming language. There are a lot of various languages. One of the most popular programming languages is C++. An Integrated Development Environment (**IDE**) is an application that provides a friendly interface for creating computer programs. We will write our programs in **Borland C++ Builder IDE**.

The main part of the IDE screen is taken up by a blank **form**. You will place different components on it. This will allow the user of your program to interact with the computer. The easiest way to add a control to the form is to click this component on the Component Palette, and click on the form. At the beginning we will use such controls as: Button, Edit Box, Label and Memo.

Any control on the form can be moved to a desired location. To move a control, click and hold your mouse on it; then drag your mouse to the desired location. To resize a control, first select it and then position your mouse on one of the indicative mouse pointers. The mouse pointer will change, indicating in what direction you can move to resize the control.

Each application is represented with a project. When you start C++ Builder, it creates a blank project by default. To create a new project, choose **New Application** from the **File** menu.

A new project automatically contains the following files:
- **Project1.cpp** – a source-code file associated with the project.

- **Unit1.cpp** – a source-code file associated with the main project form. It is called a unit file.
- **Unit1.h** – a header file associated with the main project form. It is called a unit header file.
- **Unit1.dfm** – a resource file that stores information about the main project form. It is called a form file.
- **Project1.bpr** – a main file of the project.

You should save these files to the folder you have just created by choosing **Save All** from the **File** menu. You do not need to worry about these files but do not delete them.

After starting C++ you can see a following picture (fig. 4.1):
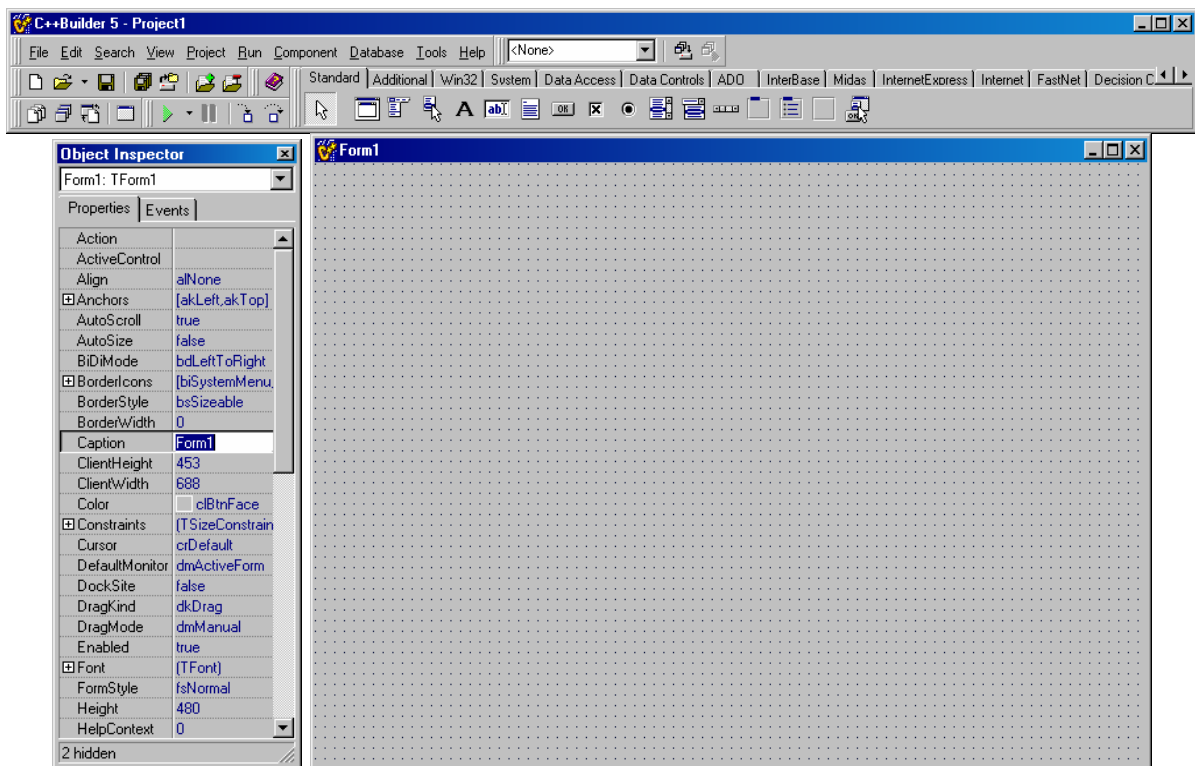
Fig.4.1 Windows and panels of C ++ environment

In the top of the screen there is the main menu (File, Edit, Search, etc.), providing access to commands of the programming environment (fig. 4.2). Below, from the left-hand side, there is the toolbar, allowing expediting often used commands of the main menu. At the right bottom of the main menu there is the Graphic palette of Components containing the big set of objects. We shall use some of them in the given work.
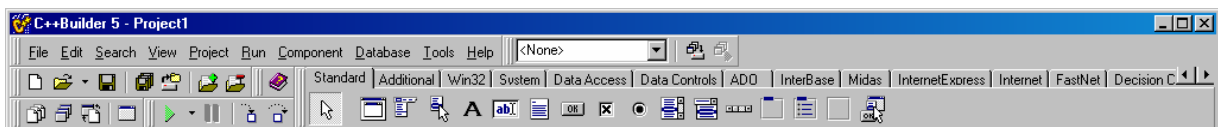
Fig.4.2 The Main menu and Component Panel

In the centre of the screen there are windows of the form with header Form1 and of the Code Editor, by default has header Unit1 (fig.4.3).
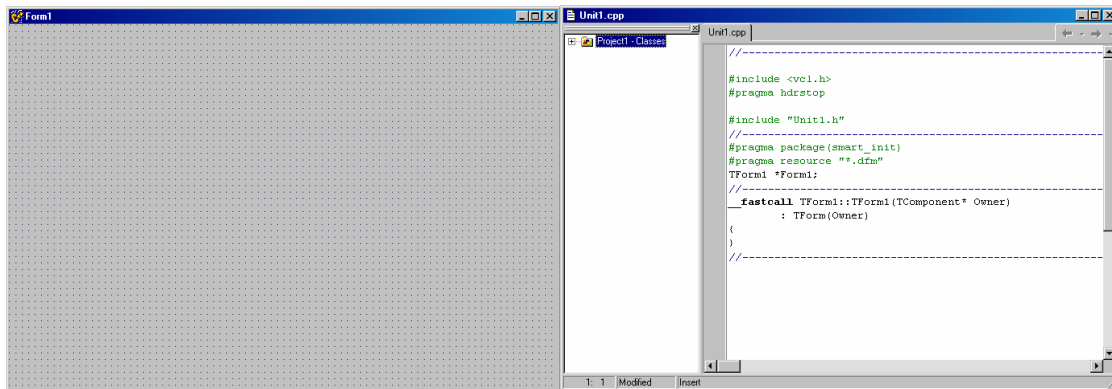
Fig.4.3 Window of the form and window of the code editor

In the left part of the screen there is a window of **Object Inspector** (fig. 4.4) which allows changing component **properties**. We shall change some properties in the given lab work.

4.3 Example 4.1

The task: Create a project with form shown below (fig. 4.5). User can change form color with click on the appropriate button ("Yellow", "Blue", "Green" and "Red").
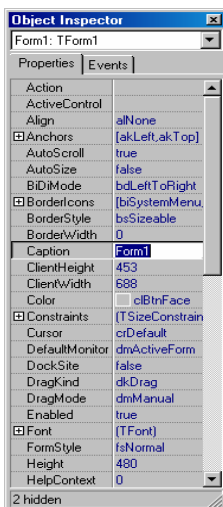
Fig.4.4 Object Inspector
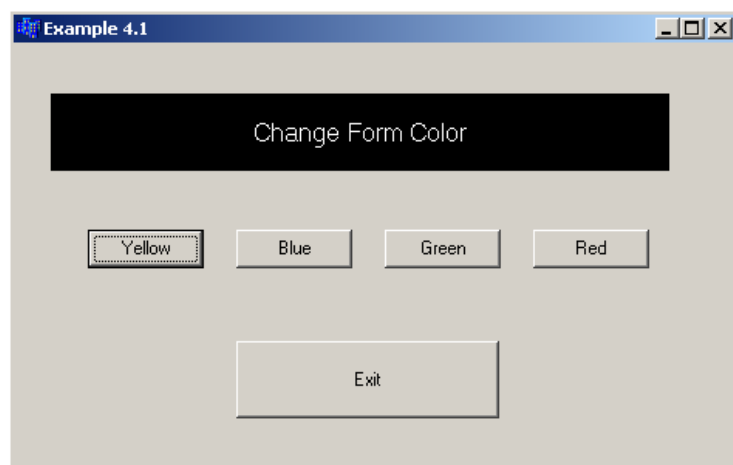
Fig.4.5 Form of example 4.1

1. Form creation

Run Borland C++ Builder. A new project with empty form will be created.

Place one Label and four Buttons on the form as it is shown in Fig 4.7. These components you can find in the **Standard** Component Palette on the top of your window (fig. 4.6).

Fig.4.6. Standard Component Palette

To place component on the form you should:
1. click on the component (select component);
2. click on the form where you want to place the component (it will appear there).

Caption, size, position on the form – are all component **properties**. You can change properties with **Object Inspector** window. To change component's property you should select the component (left click), then in Object Inspector window in Properties tab select necessary property and give it a value. Now you have to change your component properties according to the Table 4.1:
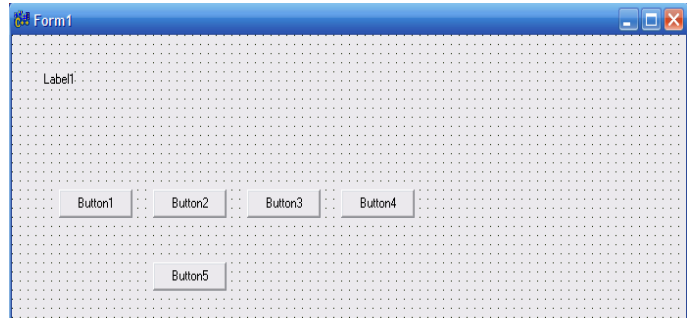
Fig.4.7 Form with components

Table 4.1 Component properties

| Name	Property	Value	Explanation
Form1	Caption	Example 4.1	Form header
	Height	300	Form height
	Width	475	Form width
Label1	Alignment	taCenter	Horizontal alignment
	AutoSize	false	We forbid the Label to change its size automatically
	Caption	Change Form Color	Label's header (text)
	Color	clBlack	Label color
	Font-Color	clWhite	Label font color
	Font–Size	12	Label font size
	Height	50	Label height
	Layout	tlCenter	Label vertical alignment
	Width	400	Label width
Button1	Caption	Yellow	Button header (text)
Button2	Caption	Blue	
Button3	Caption	Green	Button header (text)
Button4	Caption	Red	
Button5	Caption	Exit	Button header (text)
	Height	50	Button height
	Width	170	Button width

2. Event handlers' creation

After you finish designing of your form, you can start programming. Form's color will change when user clicks correspondent buttons. And now you have to program `OnClick` events for all buttons on the form. Double-click on Button1 ("Yellow"). Code Editor window will open and you will see the header for your code:

```
void __fastcall TForm1::Button1Click(TObject *Sender)
{

}
```

Attention! You should never write this header yourself or change! It must be created by C++ Builder IDE. When an event-handler is created properly (through the Borland IDE) many references to it are also created and stored in files other than Unit1.cpp.

Now all actions, which must be executed after user clicks on this button, you should write here between the curly braces (first brace "{" means "begin", second brace "}" means "end"). Write for Button1 ("Yellow") between braces:

```
Form1->Color = clYellow;
```

Here **clYellow** is a special value for yellow color. And code for `Button1 OnClick` event finally looks like:

```
void __fastcall TForm1::Button1Click(TObject *Sender)
{
    Form1->Color = clYellow;
}
```

Please, write yourself (copy and edit) the code for `Button2` ("Blue"), `Button3` ("Green"), `Button4` ("Red") `OnClick` events. Notice that blue color is **clBlue**, green – **clGreen**, red – **clRed**.

Code for `OnClick` event of `Button5` ("Exit"):

```
Close();
```

2. Run the project

Attention! You should save your project before run it. To do this select **SaveAll** from **File** menu ( ). **Advice!** Save each project in separate folder.

To run your program, you can select **Run** from **Run** menu, or press **F9** key on the keyboard or click Run-button ( ).

Notice! All commands in C++ program end with semicolon (**;**).

4.4 Example 4.2

The task: Create a program with button which runs away. Output the current date and time on the form. The form of this example is shown in fig 4.8.
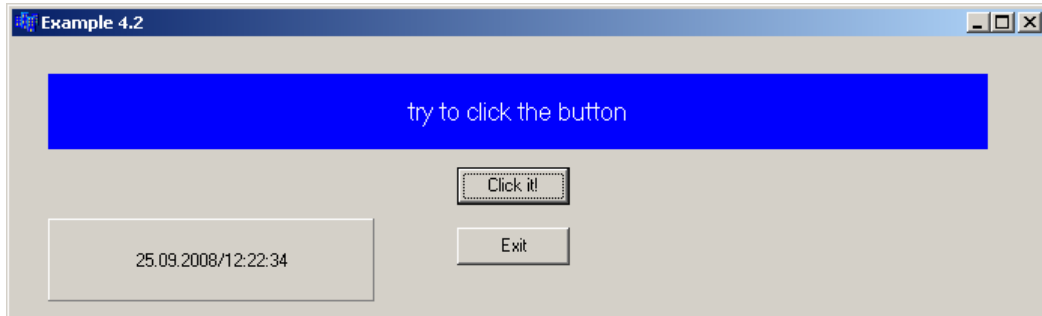
Fig. 4.8 Form of example 4.2

1. Form creation

Place one Label, one Panel, two Buttons and one Timer on the form. You can find first tree components in **Standard** Component Palette (fig.4.9):
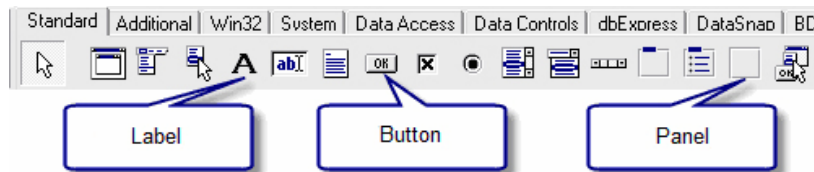
Fig. 4.9 Standard Component Palette

Timer component is in the **System** palette (fig.4.10):
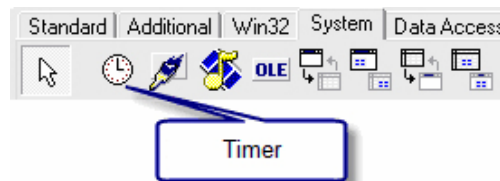
Fig. 4.10 System Component Palette

The form with components is shown in fig. 4.11:
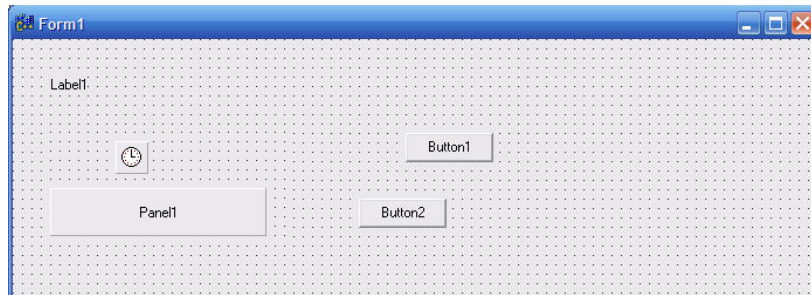
Fig.4.11 Form with components.

Then change component properties according the table 4.2:

Table 4.2 Component properties

Name	Property	Value	Explanation
Form1	Caption	Example 4.2	Form's header
	Height	210	Form's height
	Width	695	Form's width
Label1	Alignment	taCenter	Horizontal alignment
	AutoSize	false	We forbid the Label to change its size automatically
	Caption	Try to click the button	Label header (text)
Label1	Color	clBlue	Label color
	Font – Color	clWhite	Label font size
	Font – Size	12	Label font size
	Height	50	Label height
	Layout	tlCenter	Label vertical alignment
	Width	625	Label width
Button1	Caption	Click it!	Button header (text)
Button2	Caption	Exit	Button header (text)
Timer1	Interval	1000	Timer interval in msec
Panel1	Caption		Panel header (empty text)

2. Event handlers' creation

Now you must create an `OnMouseMove` event handler for `Button1` (this event occurs when we direct mouse pointer at the button). Select `Button1` and in the Object Inspector window select **Events** tab. There is `OnMouseMove` event in the left part of it. Double-click on the right part of it (near `OnMouseMove` event). Then in the Code Editor you will see the header:

```
void __fastcall TForm1::Button1MouseMove(TObject *Sender,
                    TShiftState Shift, int X, int Y)
{

}
```

Now you must write the following code between the braces:

```
if(Button1->Left <= 0)
     Button1->Left = Form1->Width – Button1->Width – 10;
else
     Button1->Left -= 5;
```

Write yourself OnClick event handler for Button2 ("Exit").

Now you must output date and time on the panel. Create OnTimer event handler (this event occurs through a period of time Interval). Write the following code:

```
Panel1->Caption=Now().DateString() + "/" + Now().TimeString();.
```

Explanation! Function Now() returns the current date and time. Method DateString() converts date to the text, metod TimeString() converts time to the text.

Now you must **save** your project and **run** it.

Laboratory work 1.5 Linear programs

The purpose is to get practical skills in writing arithmetical expressions on C++ programming language, writing programs with linear structure and creation projects in C++ Builder IDE.

5.1 Control questions

1. What is a variable?
2. What is a constant?
3. What are the basic data types?
4. What is the syntax of variable declaration?
5. Why is it necessary to declare variables?
6. What is the difference between an integer variable and a floating-point variable?
7. Which of the following variable names are good and which are invalid? Why?
   a. Age
   b. !ex
   c. R79J
   d. TotalIncome
   e. __Variable
8. What is the correct variable type to store the following information? Create good variable names for this information.
   a. Your age.
   b. The area of your backyard.
   c. The number of stars in the galaxy.
   d. The average rainfall for the month of January.
9. Declare a constant *pi* as 3.14159. Declare a float variable and initialize it using your *pi* constant.
10. What are the basic arithmetical operations in C++?
11. What is assignment?
12. What figures of flowcharts do you know?
13. What program is called linear?
14. How can we read integer value from the Edit Box?
15. How can we output float value in Edit Box?
16. How can we convert integer value to string?
17. Is C++ case sensitive? What does it mean?
18. What does #include do?
19. What is the difference between // comments and /* comments?
20. What happens if we assign a number with a decimal point to an integer rather than to a float? Consider the following line of code:

```
int aNumber = 5.4;
```

21. What is the value of `201/4`?

22. What is the value of `201%4`?

23. If `myAge`, `a`, and `b` are all `int` variables, what are their values after:

```
myAge = 39;
a = myAge++;
b = ++myAge;
```

24. What is the value of 8+2*3?

5.2 Theoretical information

The main concept of programming is a **variable**. Variables are designated by characters (*x*, *y*, *s*) or parts of words (***sum***, ***kol***, ***num***) and can contain digits (but cannot start with digit). During the program execution variables usually receive values which then are used in calculations. Numerical variables may be **integer** (to store integer numbers: 4, -7, 100, etc.) and **real** (for real numbers: 0.3, 5.2, -6.1). Before using a variable, it needs to be **declared**. The declaration of the variable consists of variable's type, variable's name and, sometimes, an initial value.

Examples of declaration:

```
float x, sum;        //variables x and sum are real
int n, kol;          //variables n and kol are integer
```

It is possible to initialize a variable's value at the declaration:

```
int a=1;
float b=8.3;
```

We can do arithmetical operations with numbers: **+** (add), **−** (subtract), ***** (multiply), **/** (divide), **%** (modulus), **++** (increasing on 1), **− −** (decreasing on 1).

Examples of arithmetical expressions (consider variables `int a=5, float b=6.5, int c,x`):

```
x=3-a;           //x=-2
c=a*(b-a);       //c=7 (c is int)
a++;             //a=6
c--;             //c=6
b=(c+1)/2;       //b=7/2=2 ((c+1)/2 is int)
```

Note that int **/** (divide) int always gives **int**.

```
b=(b+3)/4;       //b=6.0/4=1.5, b is float
a=10%4;          //a=2 – modulo (reminder of division)
```

There is a special math library in C++, which allows writing compound formulas with mathematical functions. To use it, write at the top of the program:

```
#include <math.h>
```

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List of Math Functions

int **abs** (int x) – to compute absolute value of int x
double **fabs** (double x) – to compute absolute value of float or double x
double **sqrt**(double x) – to compute the square root of x
double **pow** (double x, double y) – to compute x raised to the power y
double **exp**(double x) – to compute exponential of x
double **log**(double x) – to compute $ln\ x$
double **log10** (double x) – to compute log to the base 10 of x
double **sin**(double x) – to compute sine of angle in radians
double **cos**(double x) – to compute cosine of angle in radians
double **tan**(double x) – to compute tangent of angle in radians
double **acos**(double x) – to compute arc cosine of x
double **asin**(double x) – to compute arc sine of x
double **atan**(double x) – to compute arc tangent of x

We can use **constants** in C++ program. To declare integer constant N with value 100, we must write:

const int N=100;

5.3 Examples of programs with linear structure

Example 5.1

The task: Make a flowchart of algorithm and project in C++ Builder for computing the function W. Function W is set by the formula:

$$W=2me^z,$$

where $z = \sin^2 \sqrt{|m|}$, m is an arbitrary variable.

Enter m from the Edit Box and output on the form the intermediate function z value; the result is a function W value.

Flowchart of the task solution (it has a linear structure) is shown in fig. 5.1.

Run C++ Builder. Design the necessary interface of the form. Place 10 components on the form: `Label1`, `Label2`, `Label3`, `Label4`, `Edit1`, `Edit2`, `Edit3`, `Button1`, `Button2`, `Button3`. Change properties of these components, according to table 5.1.
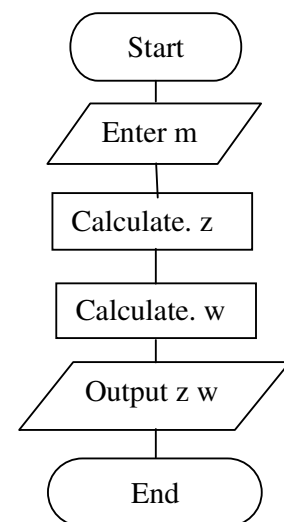
Fig 5.1. Flowchart of the algorithm with linear structure

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Table 5.1. Values of components' properties

Control	Property	Value
Form1	Caption	Program with linear structure
Label1	Caption	Press Button Clean and then enter a value of variable m
Label2	Caption	m=
Label3	Caption	z=
Label4	Caption	w=
Button1	Caption	Solve
Button2	Caption	Clear
Button3	Caption	Exit
Edit1	Text	Empty string (delete the text "Edit1")
Edit2	Text	Empty string (delete the text "Edit2")
Edit3	Text	Empty string (delete the text "Edit3")

After these operations your form should look like as in the fig. 5.2 (but without results).
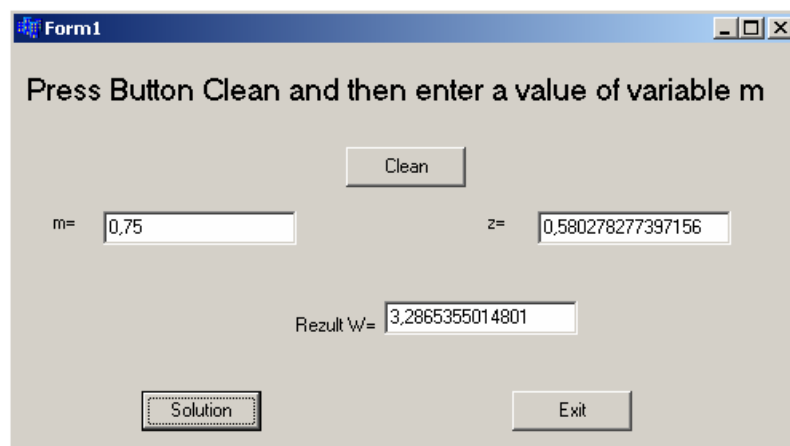
Fig. 5.2. The form of the project with results

Write the program code on `OnClick` event for each Button.

The complete text of the program is:

```
#include <vcl.h>
#pragma hdrstop
#include "Unit1.h"
#pragma package(smart_init)
#pragma resource "*.dfm"
#include <math.h>     // including the mathematical library
TForm1 *Form1;
__fastcall TForm1::TForm1(TComponent* Owner)
        : TForm(Owner)
{}
//-----------------------------------------------------------------------
//click on button "Clean"
void __fastcall TForm1::Button2Click(TObject *Sender)
```

```
    {
         Edit1->Clear();              //clear Edit1
         Edit2->Clear();              //clear Edit12
         Edit3->Clear();              //clear Edit13
         Edit1->SetFocus();           //place the cursor in Edit1
    }
//------------------------------------------------------------------------
//click on the button "Exit"
void __fastcall TForm1::Button3Click(TObject *Sender)
{
         Close();          //close the form and return to the Code Editor window
}
//------------------------------------------------------------------------
//click on the button "Solve"
void __fastcall TForm1::Button1Click(TObject *Sender)
{
//declare float variables m, z, w
float m,z,w;
//convert string, entered in Edit1, to float variable m
m=StrToFloat(Edit1->Text);
//calculate the value of z
z=pow(sin(sqrt(fabs(m))),2);
//calculate the value of w
w=2*m+exp(z);
//convert float number z to the string and write it in Edit2
Edit2->Text=FloatToStr(z);
//convert float number w to the string and write it in Edit3
Edit3->Text=FloatToStr(w);
}
```

Save your project and run it. If your program contains errors, correct them and run the project again.

Enter the value of ***m***. Click Solution button. Write the results in your report. Close C++ Builder.

Breakpoints and Stepping through the program

Borland C++ Builder has two types of stepping (or *Tracing*) environments. The default one shows a **CPU Window** containing assembly code, register contents and lots of other stuff. If this window pops up menu select **Run – Program Reset** to reset your program and close the CPU window.

To step through your program, follow these steps:

• Insert a breakpoint on the first line of code by positioning the cursor on the line then select **Toggle Breakpoint** from the right mouse button/Debug menu. *(Try Toggle Breakpoint a few times. See how the line shows as a breakpoint which can easily be cleared.)*

- Run the program using the **Run** button on the toolbar *(or select **Run – Run** from the menu system)*
- The program should pause on your breakpoint statement. Press the **Step Over** button on the toolbar to now slowly step through the program.

Adding a Watch to view variable values

Add a watch window to view the values of your variables using:
- **Run – Add Watch**
- Add a variable name for the Expression (for example, *w*)
- Also add a watch for the variable *z*

Step through your program a few times so you can see the values of your variables. Notice especially the values, which Borland C++ Builder gives them before they are initialized. (You will have to do some arranging of windows in order to view the code, watch and output windows simultaneously).

5.4 Individual task

1. According to your individual variant write on C++ arithmetical expressions from the tables 5.2, 5.3 and 5.4 in your report.

2. Create the flowchart of the algorithm and write a program in Borland C++ Builder. Your program must calculate the function *y=f(x)* according to the individual task in tables 5.5 and 5.6. In the table 5.5 you must enter value of *x* from the Edit box.

Table 5.2 Variants of arithmetical expressions for task 1

1	$Z = \dfrac{2t + y\cos t}{\sqrt{y+4,831}}$	**2**	$D = y^2 + \dfrac{0,5n+4,8}{\sin y}$	**3**	$Q = \dfrac{\sqrt{k+2,6p\sin k}}{x - d^3}$
4	$F = \ln(d) + \dfrac{3,5d^2+1}{\cos 2y}$	**5**	$R = \dfrac{\sin(2t+1)^2 + 0,3}{\ln(t+y)}$	**6**	$L = \cos^2 c + \dfrac{3t^2+4}{\sqrt{c+t}}$
7	$U = \dfrac{\ln(k-y) + y^4}{e^y + 2,355k^2}$	**8**	$A = \dfrac{\sin(2y+h) + h^2}{e^h + y}$	**9**	$R = \dfrac{\sin^2 y + 0,3d}{e^y + \ln(d)}$
10	$G = \dfrac{9,33w^3 + \sqrt{w}}{\ln(y+3,5) + \sqrt{y}}$	**11**	$P = \dfrac{e^{y+2,5} + 7,1h^3}{\ln\sqrt{y+0,04h}}$	**12**	$U = \dfrac{\ln(2k+4,3)}{e^{k+y} + \sqrt{y}}$
13	$D = \dfrac{7,8a^2 + 3,52t}{\ln(a+2y) + e^y}$	**14**	$F = \dfrac{2\sin(0,354y+1)}{\ln(y+2j)}$	**15**	$T = \dfrac{\sin(2u)}{\ln(2y+u)}$
16	$L = \dfrac{0,81\cos i}{\ln(y) + 2i^3}$	**17**	$W = \dfrac{4t^3 + \ln(r)}{e^{y+r} + 7,2\sin r}$	**18**	$G = \dfrac{e^{2y} + \sin(f)}{\ln(3,8y+f)}$
19	$N = \dfrac{m^2 + 2,8m + 0,355}{\cos 2y + 3,6}$	**20**	$H = \dfrac{y^2 - 0,8y + \sqrt{y}}{23,1n^2 + \cos n}$	**21**	$Z = \dfrac{\sin(p+0,4)^2}{y^2 + 7,325p}$
22	$T = \dfrac{2,37\sin(t+1)}{\sqrt{4y^2 - 0,1y + 5}}$	**23**	$R = \dfrac{\sqrt{\sin^2 y + 6,835}}{\ln(y+k) + 3y^2}$	**24**	$W = \dfrac{0,004v + e^{2y}}{e^{\frac{y}{2}}}$

Continuation of the Table 5.2 Variants of arithmetical expressions for task 1

25	$V = \dfrac{(y+2w)^3}{\ln(y+0,75)}$	**26**	$E = \dfrac{\ln(0,7y+2q)}{\sqrt{3y^2+0,5y+4}}$	**27**	$T = \dfrac{0,355h^2-4,355}{e^{y+h}+\sqrt{2,7y}}$
28	$S = \dfrac{4,351y^3+2t\ln(t)}{\sqrt{\cos 2y+4,351}}$	**29**	$K = \dfrac{2t^2+3l+7,2}{\ln(y)+e^{2l}}$	**30**	$N = \dfrac{3y^2+\sqrt{y+1}}{\ln(p+y)+e^p}$

Table 5.3 Variants of arithmetical expressions for task 1

1 $\;F = \cos(x^2+2)+\dfrac{3,5x^2+1}{\cos^2 y}$	**2** $T = \dfrac{\sqrt{x+b-a}+\ln(y)}{arctg(b+a)}$
3 $\;R = \dfrac{\sin(x^2+4)^3+4,3}{\sin^3 x^4}$	**4** $D = \dfrac{K^{-arx}-a\sqrt{6}-\cos(3ab)}{\sin^2(a\cdot\arcsin x+\ln y)}$
5 $\;L = ctg^2 c+\dfrac{2x^2+5}{\sqrt{c+t}}$	**6** $U = \dfrac{\ln(x^3+y)-y^4}{e^y+5,4k^3}$
7 $P = \dfrac{a^5+\arccos(a+x^3)-\sin^4(y-c)}{\sin^3(x+y)+|x-y|}$	**8** $A = \dfrac{tg(y^3-h^4)+h^2}{\sin^3 h+y}$
9 $F = \dfrac{\sqrt{(2+y)^2+\sqrt[7]{\sin(y+5)}}}{\ln(x+1)-y^3}$	**10** $R = \dfrac{\cos^2 y+2,4d}{e^y+\ln(\sin^2 x+6)}$
11 $\;G = \dfrac{tg(x^4-6)-\cos^3(z+xy)}{\cos^4 x^3 c^2}$	**12** $F = \dfrac{\sqrt{|x|+\cos^3 x+z^4}}{\ln x-\arcsin(bx-a)}$
13 $U = \dfrac{tg^3 y+\sin^5 x*\sqrt{b-c}}{\sqrt{a-b+c}}$	**14** $D = \dfrac{\cos(x^3+6)-\sin(y-a)}{\ln x^4-2\sin^5 x}$
15 $P = \dfrac{a^5+\sin^4(y-c)}{\sin^3(x+y)+|x-y|}$	**16** $G = \dfrac{tg(x^4-6)-\cos^{3x}(z+x^3 y)}{\cos^2 x^3 c^2}$
17 $R = \dfrac{\cos^3 y+2^x d}{e^y+\ln(\sin^2 x+7.4)}$	**18** $S = \dfrac{4,351y^3+2t\ln(t)}{\sqrt{\cos 2y+4,351}}$
19 $U = \dfrac{e^{x^3}+(\cos^2 x-4)}{arctgx+5,2y}$	**20** $N = \dfrac{\sqrt[5]{z+\sqrt{zx}}}{e^x+a^5*arctgx}$
21 $\;I = \dfrac{2,33\ln\sqrt{1+\cos^2 y}}{e^y+\sin^2 x}$	**22** $K = \dfrac{\sqrt{(3+x)^6-\ln x}}{e^0+\arcsin 6x^2}$
23 $K = \dfrac{\cos^3|y+x|-(x+y)}{arctg^4(x+a)*x^5}$	**24** $R = \dfrac{\sqrt{\sin^2 y+6,835}}{\ln(y+k)+3y^2}$
25 $R = \dfrac{a}{x-a}+\dfrac{b^x+\cos^3 x}{\log^3 a+4,5}$	**26** $G = \dfrac{9,33w^3+\sqrt{w}}{\ln(y+3,5)+\sqrt{y}}$
27 $L = \dfrac{\sqrt{e^x-\cos^4(x^2*a^5)}+arctg^4(a-x^5)}{e\sqrt{|a+x*c^4|}}$	**28** $f = \dfrac{\cos^7 bx^5-(\sin a^2+\cos(x^3+z^5-a)}{(\arcsin a^2+\arccos(x^7-a^2))}$

Continuation of the Table 5.3 Variants of arithmetical expressions for task 1

29 $N = \dfrac{m^2 + 2{,}8m + 0{,}355}{\cos 2y + 3{,}6}$	**30** $H = \dfrac{y^2 - 0{,}8y + \sqrt{y}}{23{,}1n^2 + \cos n}$

Table 5.4 Variants of arithmetical expressions for task 1

Var. №	Arithmetical expression
1	$V1 = \sqrt{x^2 + \sqrt{arctg|x| - e^2} \,/\, \sin^2\left(x^3 + 1.8\right)^4} + 2.8^{\sqrt{|x|}}$
2	$V2 = \left(\sin x - 5.4\right)^{3x} + \sqrt[3]{\left|\lg(x - 1.5)^2\right|} + x^{3.5}$
3	$V3 = x^{2.8} \;/\; \left(\cos^2\left(x^3 - 1.5\right)^4 + \sqrt{|x|}\right) - arctg\left(x / \ln|x|\right)^5$
4	$V4 = \sin^5\left(x^4 - \sqrt[3]{\lg^4\left(x^2 - \ln^2\left(x - 1.8^{3.4}\right)\right)}\right) + arctg^2 x$
5	$V5 = \left(15.4^x - x^{3.9}\right) / \sqrt{x^2 + \lg^2 \ln^3\left(\left|x^3 - 1.8\right|\right)} + 9^{5.3}$
6	$V6 = e^{\sqrt{\lg^3\left(x^2 - 1.8\right)^3}} + x^{4.5} \,/\, arctg(x^2 + a^2)^4 - \sqrt{x^{3.2}}$
7	$V7 = \left(\cos^3 x^{1.5} + \sin^2 x^3\right)^4 / \left(\lg^2\left(|x| + e^{\sqrt[3]{x+1.8}}\right) + \sqrt{|x|}\right)$
8	$V8 = \lg^4\left(\ln^3\left(x^2 + \sqrt{|x|}\right) / \left(x^3 + e^x\right)^3\right)^5 - x^{3.5} / \sin^2\left(x^3 + 1.8\right)$
9	$V9 = \cos^5\left(x^2 + arctg\sqrt{|x - 1.8|}\right) / \sin^2\left(x^2 + 1.5\right)^5 + \sqrt[3]{x^{3.5}}$
10	$V10 = arctg^5\left(\sin^3\left(x^2 + 1.8\right)^5 - \sqrt{x}\right)^4 - e^{3.8} \,/\, \left(x^{4.5} + \sqrt{|x|}\right)$
11	$V11 = \cos^3\left(x^4 + \lg^2 \ln^3\left(\sqrt{x} - \sqrt[3]{|x|}\right)^2\right)^5 + \left(4.8^{\sqrt[3]{x}} - \sqrt{|x|}\right)^5$
12	$V12 = \sin^8\left(\sqrt{x} + \sqrt[3]{|x^2 + 1.8|} \,/\, \cos^2\left(x^3 - 1.5\right)^6\right)^9 - x^{3.7}$
13	$V13 = e^x\left(\cos^2\left(|x| - \sqrt[3]{x^4 + 5.3}\right)^4 + arctg^3 x^2\right)^5 + x^2 / \left(1 + x^{6.6}\right)$
14	$V14 = \sqrt[3]{|x|} + \sqrt{x^3 + 1.3} \,/\, \cos^2 x^3 \left(1 + x\right)^4 \,/\, e^{\sqrt{x}} - x^{7.5}$
15	$V15 = \sin^5\left(\sqrt{|x|} + \cos^3\left(x^2 + 5.4\right)^6\right)^7 - arctg\left(e^{\sqrt{x}} + 5.8^{3.7}\right)$
16	$V16 = \left(x^2 + \sqrt{\sin^2 x - \ln x^2}\right) / \lg^2\left(x + \sqrt[3]{5.5x + \ln x}\right)^3 - e^{2.5 + x^2}$

Continuation of the table 5.4 Variants of arithmetical expressions for task 1

17	$V17= \cos^2\left(x^2+\sqrt{x+2}\right)/\sin\left(x^2+\sqrt{x}\right)+\ln^2 x/\left(\lg x+e^{\sqrt{x}}\right)$
18	$V18=\sqrt{x^2+\sin\left(\sqrt{x}+2x\right)^2}-e^{2x+\sqrt{x}}/\left(\cos^2 x+\lg^2\ln x\right)^2$
19	$V19=\sqrt[3]{x}+\cos^2 x+\sin x^2+\lg x/\left(x^2+\ln^2 x^3-e^{\sqrt{x}}\right)$
20	$V20=\sqrt{x+\sqrt{x+\sqrt{x+\sin^2 x}}}/\left(\cos(x^2+\ln^2\left(1+e^{\sqrt{x}}\right))\right)$
21	$V21=\left(x^2+\cos\left(x+\ln\sqrt{x^3+1.8}\right)^2+\sqrt{|x|}\right)/\left(\lg\left|x+e^{\sqrt{x}}\right|\right)$
22	$V22=\sin^3\left(x^2\sqrt[3]{x}+\sqrt{x^2+1.5}\right)/arctg^2\left(x^2+1.5e^x\right)$
23	$V23=\cos^2\left(x+\sin\left(\sqrt{x^3+\sqrt{x+1.5}}-\ln^2 x\right)+e^x\right)$
24	$V24=\left(x^{4.5}e^{\sqrt{x}}\right)/\ln^2\left(x^2+\cos\left(x+\sqrt[3]{x}\right)\right)-\sin^3\left|x-e^3\right|$
25	$V25=arctg^2\left(x^2+\cos\left(\sqrt{x+\left|x^2-e^x\right|}\right)/\lg^2\left(x^3-\sin x\right)\right)$
26	$V26=\sin^2\left(x^2+\sqrt[3]{x+\cos^2|x|}\right)/\ln^2\left(\sqrt{x}-arctg^2|x|\right)^2$
27	$V27=\ln^2\left(\sqrt{|x|}+x^2+\sin|x|\right)/\lg^2\left(e^{\sqrt{x}}+x^4\right)$
28	$V28=\lg\left(\left|x^2+\sqrt{x^2+1.5}\right|\ln^2(x)\right)/e^{\sqrt{x}}+\cos^3 x^2$
29	$V29=\cos^3\left(arctg^2\left(\left|x+\sqrt[3]{x}\right|\right)+\sin^2 x\right)/\sin\left|\lg^2(x+2.8)\right|$
30	$V30=\lg^5\left(x^3\ln^6\left(x^2+1.7\right)^9+e^{\sqrt{x}}\right)^2-arctg\left|\sqrt[3]{x}+tg^3 x^8\right|$

Table 5.5 Variants of arithmetical expressions for task 2

Var. №	Function
1	$$Y = \frac{2x^2 = \sin^2 x}{\cos(2x) + x^2} - \frac{x+1}{\ln x}$$
2	$$Y = \frac{\ln x^2 + \cos^2 x}{\cos(2x) + x^2} * \frac{\sqrt[3]{x}}{x}$$
3	$$Y = \frac{\ln x^2 + 2\cos^2 x}{\cos(2x)^2} + \frac{\sqrt[3]{x}}{x}$$
4	$$Y = \frac{2\cos^2 x}{1 + x\cos(2x)} + \frac{0,3^x}{x\ln x = 2\sin^2 x}$$
5	$$Y = \frac{x + 2x + \sin x}{\cos^2 x + x^2} + \frac{0,3^x}{\ln x}$$
6	$$Y = \frac{2x + \sin x}{\cos^2 x + x^2} + \frac{0,5^x}{\sqrt{x}}$$
7	$$Y = \frac{\sin x - x^2}{2x + 1} + \frac{(1+x)^x}{1 + 3x}$$
8	$$Y = \frac{x - \ln x}{2x = 1} + \frac{2x - 1}{x^2 + 3x}$$
9	$$Y = \frac{\ln x + 2x}{x^2 + 1} * \frac{x+1}{2x^2 + 1}$$
10	$$Y = \frac{3x^2 + 2x}{\sin x + x^2} - \frac{2x}{(1+x^2)(1+2x)}$$
11	$$Y = \frac{4x^2 + 3x}{(1+x)(1+2x)} * \frac{2x+1}{\sin x + 1}$$
12	$$Y = \frac{(2x^2 - 1)}{x^2 + \sin} * \frac{2x+1}{(x+2)(x+3)}$$
13	$$Y = \frac{(4x^2 - 2)(x+2)}{2x+3} + \frac{x^2 \sin x}{2x+1}$$
14	$$Y = \frac{x^2 + 2\sin x}{2x+1} + \frac{\sqrt{x} - \cos x}{(2x+1)(\ln x^2 + 1)}$$
15	$$Y = \frac{x^2 + 2(x-1)}{(x+1)(x+\sqrt{3})} + \frac{2\sin^2 x}{2x + 3^x}$$
16	$$Y = \frac{x^2 + \sin 2x}{2\sqrt{x} + 3x} + \frac{x^2 + 1}{(x+2)(x+3)}$$
17	$$Y = \frac{2x^2 + 1}{x + \sin(x+1)} + \frac{x\_3^x}{(2x+1)(x+2)}$$

Continuation of table 5.5 Variants of arithmetical expressions for task 2

Var. №	Function
18	$Y = \dfrac{3x^2 - \sqrt[3]{x}}{(2x+1)(1+x)} + \dfrac{2x+1}{(x+3)}$
19	$Y = \dfrac{2x+1}{x+1} + \dfrac{x^2 + \sqrt{x}}{(2x+1)(x+\sin x)}$
20	$Y = \dfrac{2x+3^x}{(x+1)(x+3)} + \dfrac{x^2 + \sqrt{x}}{(2x+1)(x+\sin x)}$
21	$Y = \dfrac{4x}{(x+\sin)^2} + \dfrac{2x+\sqrt[3]{x}}{(x^2+1)(x+1)}$
22	$Y = \dfrac{3x+4}{(x+3)(x+1)^2} + \dfrac{2x\_1}{(x+\sin x)(\ln x + 1)}$
23	$Y = \dfrac{2x+\sin x}{(x+2)(x+\sqrt{x})} + \dfrac{4x}{(2x+\sqrt[3]{3})(x^2+1)}$
24	$Y = \dfrac{4x\_\sin x}{x^2+3x+1} + \dfrac{3x^2+2^x}{(x+1)(x^2+1)}$
25	$Y = \dfrac{3x+2}{2x+3} + \dfrac{x^2}{(2x+1)(\sin x + 2)}$
26	$Y = \dfrac{4x^2+3x}{3x+4} + \dfrac{\sin x}{2\cos x + 1}$
27	$Y = \dfrac{x^2+1}{x^3+3} + \dfrac{\sin x}{2x+3}$
28	$Y = \dfrac{x^2-2x}{(2x+3)(x+4)} + \dfrac{\sqrt[3]{x}}{2x+3}$
29	$Y = \dfrac{3x\_2}{(2x+3)(x+1)} + \dfrac{\sin 2x}{(x^2+1)(x+2)}$
30	$Y = \dfrac{4x^2-3^x}{2x^2+1} + \dfrac{\ln x}{2x+3}$

Table 5.6 Variants of individual problems for task 2

1 Calculate the cosine of the angle between vectors $\vec{a} = (a1,a2)$ and $\vec{b} = (b1,b2)$ under the formula $\cos\alpha = \dfrac{\vec{a}\cdot\vec{b}}{|\vec{a}|\cdot|\vec{b}|}$. Absolute value of vector is $|\vec{a}| = \sqrt{a_1^2 + a_2^2}$. Formula for scalar product of vectors is $\vec{a}\cdot\vec{b} = a1b1 + a2b2$.	2 Calculate the distance between a point M and the planes $22x - 4y - 20z - 45 = 0$ and $3x - y + 5z + 1 = 0$ under the formula: $\rho = \dfrac{|ax_0 + y_0 + cz_0 + d|}{\sqrt{a^2 + b^2 + c^2}}$. Enter coordinates of the point M from the screen.

Continuation of table 5.6 Variants of individual problems for task 2

3 The body moves under the law $S = t^3 - 3t^2 + 2$. Calculate a speed of the body and a distance in instant T. Enter the value of T from the screen (function of speed is derivative of function of distance).	**4** Enter coordinates of the point on the plane (x, y). Convert dekart coordinates in polar coordinates (ρ, ϕ), where $\rho = \sqrt{x^2 + y^2}$, tg $\phi = y/x$.
5 Enter the sides of the triangle a, b and c from the form. Find medians of the triangle which sides are medians of the initial triangle. The length of the median lead to the side a, is $0{,}5\sqrt{2b^2 + 2c^2 - a^2}$.	**6** Calculate the roots of the equation $ax^2 + bx + c = 0$, with coefficients a, b, c (assume, that $a \neq 0$ and the roots are real). Enter the values a = 2, b = −8, c = −10 from the screen.
7 At change of a current strength in the spool with inductance L = 0,5H in n = 2 times the energy of a magnetic field has varied on ΔW = 3J. Find initial values of energy $W_1 = \dfrac{\Delta W}{n^2 - 1}$ and a current strength $I_1 = \sqrt{\dfrac{2W_1}{L}}$.	**8** A triangle ABC is defined by its sides a, b, c. Find its bisectrixes (the bisectrix lead to the side a, is equal to $\dfrac{1}{b + c}\sqrt{bc(a + b + c)(b + c - a)}$. Enter a, b, c enter from the screen.
9 Calculate the square of a triangle using the Heron formula. Enter the lengths of the sides a, b, and c from the screen.	**10** Calculate a length and a square of the circle. Enter the value of radius from the screen.
11 The tetragon is set by coordinates of its vertexes. Find perimeter of the tetragon. Enter coordinates of vertexes from the screen.	**12** Calculate the perimeter of the triangle. Enter the coordinates of vertexes from the screen.
13 Calculate the radius and the square of the circle with the set length. Enter the value of length from the screen.	**14** Calculate a square of the triangle. Enter coordinates of vertexes from the screen.
15 Calculate a root of the equation $2x/a + b - 12 = 0$ at various values of parameters a, b. Enter the values of a (a≠0), and b from the screen.	**16** Calculate a hypotenuse and a square of a right-angled triangle with two given cathetuses. Enter the lengths of the cathetuses from the screen.
17 In an oscillating circuit capacity of the condenser C = 10^{-6}F, inductance of the spool L = 0,04 H, amplitude of the voltage on condenser U = 100V. Calculate an amplitude of current strength $I = U\sqrt{\dfrac{C}{L}}$; complete energy $W = \dfrac{LI^2}{2}$.	**18** Calculate Z = (R1 + R2 + R3)/3, where $R1$, $R2$, $R3$ - radiuses of spheres with sizes $V1$, $V2$, $V3$ accordingly. Radius of a sphere is R = $\sqrt[3]{\dfrac{3V}{4\pi}}$. Enter the values of sizes from the screen.

Continuation of table 5.6 Variants of individual problems for task 2

19 The body moves under the law $S = t^3 - \sqrt{t}$. Calculate the speed of the body and the distance in instant **T**. Value of **T** enter from the screen (the function of speed is a derivative of the function of distance).	**20** Write the program to calculate a cathetus and a square of a right-angled triangle with given cathetus and hypotenuse. Enter the lengths of the cathetus and hypotenuse from the screen.
21 Calculate a value of function: $\text{sh}(x) \cdot \text{tg}(x+1) - \text{tg}^2(2 + \text{sh}(x-1))$ for float **x.** Enter the value of **x** from the screen. $\text{sh}(x) = \dfrac{e^x - e^{-x}}{2}$	**22** Find a period **T** and a frequency **ν** of oscillations in a contour, **C** is the capacity of condenser, **L** is inductance. Enter values of **C** and **L** from the form. $T = 2\pi\sqrt{LC}$, $\nu = \dfrac{1}{T}$.
23 Calculate Z = (v1 + v2 + v3)/3, where v1, v2, v3 are the volumes of spheres with radiuses R1, R2, R3 (V = 4/3 π R3). Enter the values of radiuses from the screen.	**24** Triangle ABC is defined by its sides **a**, **b**, **c**. Calculate its medians (the median lead to the side **a**, is equal to $0,5\sqrt{2b^2 + 2c^2 - a^2}$. Enter the values of **a**, **b**, **c** from the screen.
25 Calculate a root of the equation $7x/a + 3b - 4 = 0$ at various values of parameters **a** and **b**. Values of **a**, **b** enter from the screen.	**26** Calculate a cathetus and hypotenuse of a right-angled triangle with given second cathetus and square. Lengths of second cathetus and square enter from the screen.
27 At what value of power on the condenser of an oscillating circuit (in shares of amplitude value $\dfrac{u}{U_{max}}$) and through what time (in shares of the period t/T) energy of the electrical field will differ from the energy of a magnetic field in **n** times? Enter the value of **n** from the screen. $\dfrac{u}{U_{max}} = \sqrt{\dfrac{n}{n+1}}$; $\dfrac{t}{T} = \dfrac{\arccos\sqrt{\dfrac{n}{n+1}}}{2\pi}$.	**28** Calculate a volume of the truncated pyramid which bases are squares with the sides **a** and **b**. $V = h(S_1 + \sqrt{S_1 S_2} + S_2)/3$; **S1, S2** - squares of the bases, **h** - height of a pyramid. Enter the values of **a, b, h** from the screen.
29 Calculate the side **a** of the equilateral triangle. Enter square of the triangle from the screen.	**30** Enter the value of the square of rectangle and its perimeter. Calculate the sides of this rectangle.

Laboratory work 1.6 Console Application

The purpose is to get acquaintance to the console input/output, get practical skills in writing arithmetical expressions on C++ programming language and writing console C++ programs with linear structure.

6.1 Control questions

1. What is console?
2. What is console application?
3. How can we input the variable's value?
4. How can we output some text on the console screen?
5. How can we make a line break (two ways)?
6. How can we output a variable's value on the console screen?
7. Look at the following program and try to guess what it does without running it.

```
#include <iostream.h>
int main()
{
  int x = 5;
  int y = 7;
  cout<<endl;
  cout << x + y << " " << x * y;
  cout<<endl;
  return 0;
}
```

8. Find an error in the following program:

```
#include <iostream.h>
void main()
{
  cout << Is there a bug here?";
}
```

6.2 Theoretical information

You can use C++ Builder to create console application:

1. Start Borland C++ Builder. From the main menu, click **File – New – Other** (or **File – New**). You will see window as in fig. 6.1.

2. From the **New Items** dialog box, click the **Console Wizard** icon and click OK.

3. In the **Console Wizard** dialog, make sure the **C++** radio button is selected (fig. 6.2).

4. Click OK.

Every console application starts with a function called **main()**.
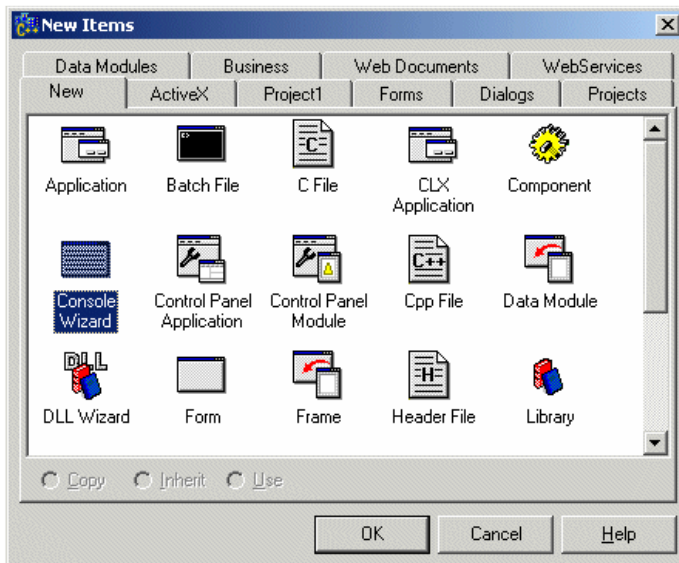Notice that console application has **no form**.
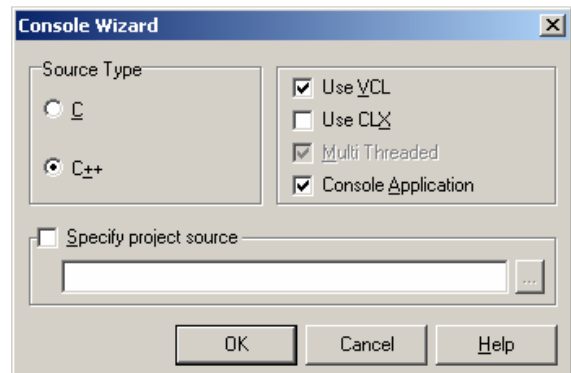
| Fig. 6.1 New Items dialog | Fig. 6.2 Console Wizard dialog |

In the last Laboratory work you entered numbers on the form in Edit Boxes. The program started calculation only after pressing the appropriate button on the form. In the console program execution starts right after the program runs. Execution occurs in a **black screen**. To input data, it is necessary to write the special command. At execution of this command the program will stop and wait, until the user will enter data and press the Enter key. Output of results is made in the same black screen and always requires remarks and hints to the user.

To output a text in console window, we can use **cout<<** command and write text in inverted commas:

```
cout<<"text";
```

To output the variable's value, we use **cout<<** command and write the variable without inverted commas. For example, to output the value of the variable *x*, we can write:

```
cout<<x;
```

To output the variable *x* with hint, we can write:

```
cout<<"Value of variable x is: "<<x;
```

If we want to move the cursor on a new line after output of the information, it is necessary to write **<<endl** in the end of the command or add "\n" to the outputted text:

```
cout<<"Value of variable x is: "<<x<<endl;
```

The following command is equivalent to the previous:

```
cout<<"Value of variable x is: "<<x<<"\n";
```

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To input the value of the variable **x** from the keyboard, we can use **cin>>** command:

```
cin>>x;
```

After the program finishes its work, black window closes. Usually we have no time to see results. To stop the program we must write the following command at the end of the program before return 0:

```
getch();
```

Notice! To use **cin** and **cout** we must write

```
#include <iostream.h>
```

at the beginning of the program.

To use **getch** we must write

```
#include <conio.h>
```

at the beginning of the program.

6.3 Example 6.1 - console linear program in C++ Builder

The task: Make a console program in C++ for computing the function **W**. Function **W** is set by the formula:

$$w = 2me^z, \quad z = \sin^2\sqrt{|m|}, \quad \text{where } m \text{ is an arbitrary variable.}$$

Enter **m** from the keyboard and output with the value of intermediate function on the screen; the result is a value of function **w**.

Structure flowchart of solving the task was shown in fig. 5.1.

Run C++ Builder and create console application.

Include **iostream.h** for cin and cout, **math.h** for mathematical functions and **conio.h** for getch() at the beginning of your program.

Write the code of program inside function **main()**. The complete code of the program is:

```
#include <vcl.h>
#include <iostream.h>        //for cin and cout commands
#include <math.h>            //for mathematical functions
#include <conio.h>           //for getch
#pragma hdrstop
//-------------------------------------------------------------------------
#pragma argsused
int main(int argc, char* argv[])
{
    float m,z,w;             //declare float variables m, z, w
    cout<<"Input a value of variable m: ";//Output the hint for input m
    cin>>m;                  //Input m from the keyboard
```

```
    z=pow(sin(sqrt(fabs(m))),2);      //calculate the value of z
    w=2*m+exp(z);                //calculate the value of w
//Output the value of z and move the cursor on the next line
    cout<<"Rezult z = "<<z<<endl;
//Output the value of w and move the cursor on the next line
    cout<<"Rezult w = "<<w<<endl;
    getch();                     //Stop program to see results
    return 0;
}
```

Save your program and run it. If your program contains errors, correct them and run the program again. After running you will see the black window with a prompt to input **m** (fig. 6.3):
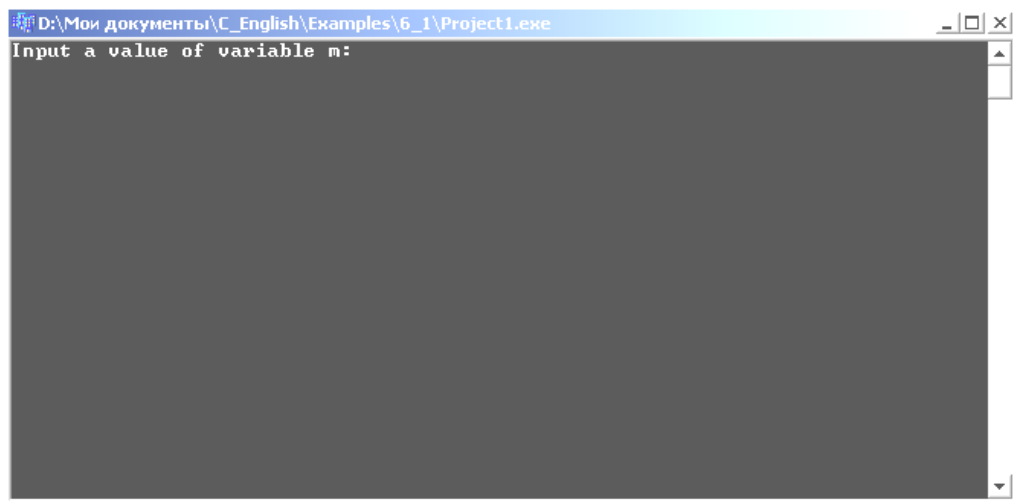
Fig. 6.3 Console window

Type number for **m** and press Enter. You will see results (fig. 6.4).
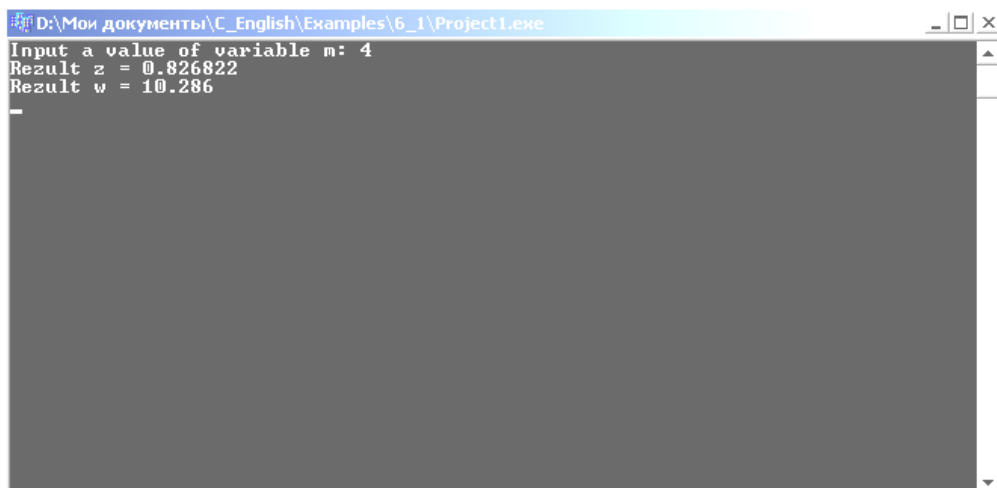
Fig. 6.4 Console window with results

Write results into your report and press Enter. Console window will close.

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6.4 Example 6.2 - console linear program in C++ Builder

The task: Make a console program in C++ for computing the function **h**. Function **h** is set by the formula:

$$h = \frac{x^{y+1} + e^{y-1}}{1 + x * |y - tgz|} * (1 + |y - x|) + \frac{|y - x|^2}{2} - \frac{|y - x|^3}{3},$$

Constant z= -130. Input the values of **x** and **y** from the keyboard. Use scanf and printf for input and output.

Result of the program is shown in fig. 6.5
Text of the program:

```
#include <stdio.h>
#include <conio.h>
#include <math.h>
#include <vcl.h>
#pragma hdrstop
//---------------------------------------------------------------------------
#pragma argsused
int main(int argc, char* argv[])
{
    const int z=-130;
    double x,y;
    double h, dop, c;
    clrscr();
    printf ("Input x: ");
    scanf ("%f", &x);
    printf ("\nInput y: ");
    scanf ("%f", &y);
    dop=fabs(y-x);
    c=0.5*pow(dop,2)-pow(dop,3)/3;
    h=(pow(x,y+1)+exp(y-1))/(1+x*fabs(y-tan(z)))*(1+dop)+c;
    printf("\n Result: h=%lf", h);
    getch( );
    return 0;
}
```


Fig. 6.5 Console window with results

6.4 Individual task

Create a console program to calculate the function *y=f(x)* according to the individual variant in the table 6.1. First of values in the table set as a constant, second value enter from the keyboard.

Table 6.1 Variants of arithmetical expressions

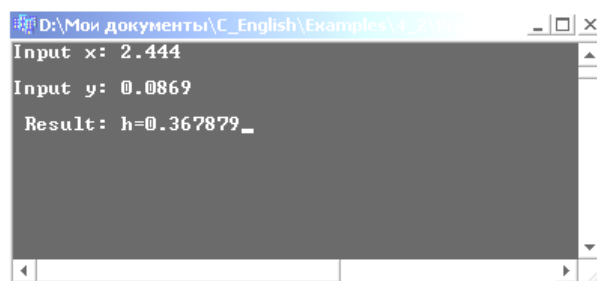| № of variant	Function Y=F(x)	Parameters' values
1	$y = a\sin^2 b + b\cos^2 a$; $a = \sqrt[3]{|b+c|}$; $b = \sqrt{x}$	x=1.52 ; c=5
2	$y = a^2 + b^2$; $a = \ln|x|$; $b = e^k + a$	x=5.3 ; k=3
3	$y = e^x + 5.8^c$; $c = a^2 + \sqrt{b}$; $a = b^3 + \ln|b|$	x=2.5 ; b=3
4	$y = \sqrt[3]{|a-b|}$; $a = \lg x$; $b = \sqrt{x^2 + t^2}$	x=1.7 ;t=3
5	$y = a^3 / b^2$; $a = e^{\sqrt{|x|}}$; $b = \left(\sin p^2 + x^3\right)$;	x=2.1 ; p=2
6	$y = p^2 + t^4$; $p = x^2 - \sqrt{|x|}$; $t = \sqrt[3]{x + a^2}$	x=4 ; a=3.7
7	$y = c^3 / \cos c$; $c = a^2 + b^2$; $a = \sqrt{|x|} + e^{\sqrt{b}}$	x=−11 ; b=12.5
8	$y = \sin^3(a+b)$; $a = t^3 + \sqrt{b}$; $b = \lg^2|x|$	x=10.9 ; t=2
9	$y = arctg^3 x^2$; $x = p + k$; $k = \sqrt{p + t^2}$	t=4.1 ; p=3
10	$y = \cos^2(a + \sin b)$; $a = \sqrt{|x|}$; $b = x^4 + m^2$	m=2 ; x=1.1
11	$y = \sin^3 a + \cos^2 x$; $a = c + k^2$; $c = arctg|x|$	k=7.2 ; x=5
12	$y = e^{\sqrt{|x|}} + \cos x$; $x = a + c^3$; $a = \sin^5 b$	b=3 ; c=1.7
13	$y = a\cos x - b\sin x$; $x = \sqrt[3]{a - b}$; $a = t^2 b$	t=2.2 ; b=3
14	$y = \sqrt{x}\sin a + \sqrt{b}\cos x$; $a = \lg|x|$; $b = x + p^3$	x=11 ;p=2.6
15	$y = \lg a / \lg b$; $a = \sqrt{x^2 + b^2}$; $x = e^b + N$	N=9.1 ; b=3
16	$y = \ln|x + t^3|; x = t^2 + p; c = (M + p)^2$	M=3.8 ; p=2
17	$y = e^{a+b}$; $a = \lg|t + b^2|$; $t = b^2 + \sqrt{bx}$	b=3 ; x=5.2
18	$y = \sqrt[3]{x^2 + c^2}; x = e^{mk}; c = \cos^2 m + k^2$	k=2 ; m=1.8
19	$y = p + v^3$; $p = \lg|x|$; $v = \sqrt{x + t} / \left(t^2 + x^2\right)$	x=5 ; t=1.8
20	$y = x^3 / t^2$; $x = e^{\sqrt{p+a}}$; $t = p^3 + a^3$	a=2 ; p=2.6
21	$y = c^2 + \sqrt{|a|}$; $c = \lg|b|$; $a = (b + x)^3$	b=2.5 ; x=2

Continuation of the table 6.1 Variants of arithmetical expressions

№ of variant	Function Y=F(x)	Parameters' values
22	$y = arctg^2|x|; x = t^3 + b^2; t = b^3 + e^{\sqrt{q}}$	q=2 ; b=1.8
23	$y = v^3 + \cos^2 w$; $v = \cos^2 a$; $w = \sqrt{a + |x|}$	x=2.9 ; a=-0.9
24	$y = x^2 + \sqrt[3]{|x|}$; $x = \cos^2 b + \sin^2 a$; $a = \sqrt{b + t^2}$	b=7.1 ; t=2
25	$y = \sin^3 x + \cos x^2$; $x = \lg|ct|$; $c = t^2 + \sqrt{a}$	t=-3 ; a=8.8
26	$y = \lg^2|x + a|$; $x = \sqrt{a + b}$; $a = e^{t+b}$	t=2 ; b=1.8
27	$y = arctg^3|p|$; $p = \sqrt{x^2 + a^2}$; $x = \sqrt{a} + \sqrt{b}$	a=7 ; b=2.3
28	$y = \ln^2(p + t)^2$; $p = e^{\sqrt{t}}$; $t = x^2 + \sqrt{|n|}$	x=3 ; n=-1.9
29	$y = \cos^3 x + |a|; x = e^b; b = |a| + \sqrt{a + p^2}$	a=-4 ; p=3
30	$y = \sin^4(a^2 + b^2)$; $a = \sqrt{b + t}$; $t = b^2 + k^3$	b=2 ; k=1.8

Laboratory work 1.7 Relational operations. If conditional statement

The purpose is to get acquaintance to relational operations and if conditional statement, get practical skills in writing branching programs.

7. 1 Control questions

1. What relational operations in C++ do you know?
2. What is condition in C++?
3. How can we check, whether the variable is odd?
4. Are negative numbers `true` or `false`?
5. What is the difference between `x = 3` and `x == 3`?
6. Do the following values evaluate to `true` or `false`?
    a. 0
    b. 1
    c. -1
    d. x = 0
    e. x == 0 *// assume that x has the value of 0*
7. How can we write logical AND, OR and NOT in C++?
8. What is the syntax of IF statement?
9. What is the flowchart of IF statement?
10. How can we write the nested IF statement? Draw the flowchart.
11. Write a single if statement that examines two integer variables and changes the larger to the smaller, using only one else clause.

7.2 Theoretical information

Conditions

C++ provides six relational operations (table 7.1) for comparing numbers. Relational operators evaluate to **1** (representing the `true` outcome) or **0** (representing the `false` outcome).

Table 7.1 Relational operations

Operator	Name	Example
==	Equality	5==5 *//gives 1*
!=	Inequality	5!=5 *//gives 0*
<	Less than	5 < 5.5 *//gives 1*
<=	Less than or equal	5 <= 5 *//gives 1*
>	Greater than	5 > 5.5 *//gives 0*
>=	Greater than or equal	6.3 >= 5 *//gives 1*

Examples of conditions:

```
x>0          (x is a positive number)
x==9         (x equals to 9)
x!=y         (x is not equal to y)
x%2==0       (x is an even number)
x%6!=0       (x is not multiple to 6)
x>0&&x<10    (0<x<10, i.e. x is greater than 0 and less than 10)
x<0 || x>10  (x<0 or x>10)
!x           (not x is true, i.e. the same is x==0)
```

Priority of relational operations is lower than arithmetical operations.

If statement

The **if** statement allows your program to make a decision. Its syntax is:

```
if (condition)
   { action1 }
else
   { action2 }
```

If the *condition* in parenthesis is true, all code inside the first braces is executed, if it is not, the code inside the first braces is ignored and the code inside the second braces after *else* is executed.

Condition is a value or an expression that is used to determine which code block is executed, and the curly braces act as "begin" and "end" markers. Note that conditions always are written in **parenthesis**.

If you have only one statement in *action1* or *action2*, then the correspondent braces are not required.

Examples of use conditions in program:

1. Calculate the quotient of two numbers, if it is possible.

```
if (y!=0)
    r=x/y;
```

2. Calculate the square root of the variable *x*, if it is possible.

```
if (x>=0)
    y=sqrt(x);
else
    ShowMessage("Can not calculate");
```

3. If variables *x* and *y* are equal, calculate their product, otherwise calculate an absolute value of their difference.

```
if(x==y) r=x*y;
else r=fabs(x-y);
```

In examples 1-4 braces are not necessary.

4. If absolute values of *x* and *y* are less than *10*, increase them twice; otherwise reduce them twice.

```
if (fabs(x)<10&&fabs(x)<10)
{
    x=x*2;
    y=y*2;
}
else
{
    x=x/2;
    y=y/2;
}
```

In this example both two statements should be executed if the condition is true, therefore we must write braces.

Statements in braces are called **block** of statements.

In the flowcharts **if** statement is drawn as shown in fig. 7.1.
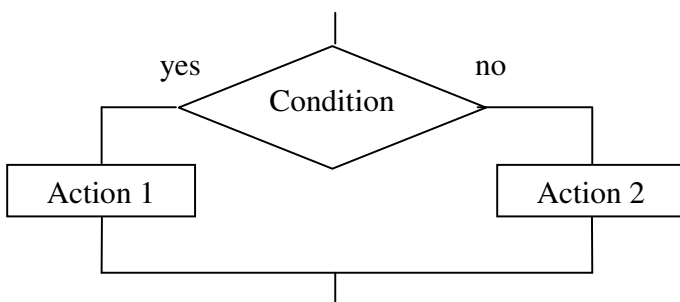
Fig. 7.1 If statement flowchart

There may be any statements instead of *action1* or *action2*, including another if statement.

Example: define the sign of variable *x* (it may be positive, negative or zero).

```
if (x>0) ShowMessage ("positive");
else
    if (x<0) ShowMessage("negative");
    else ShowMessage ("zero");
```

First *else* means that *x* is a negative number or zero. Therefore we should check up both of these variants.

7.3 Example 7.1 - program with branching

The task: Enter a value of *x* and calculate the value of *y*:

$$Y = \begin{cases} 2x^3 + 4x & x \le -1 \\ x + 4 & -1 < x < 3 \\ 2x + 2 & x \ge 3 \end{cases}$$

The form of the project with results is in fig. 7.1:

Fig. 7.1 The form of the project and results (example 7.1)

Text of the program:

```
#include <math.h>
…
void __fastcall TForm1::Button1Click(TObject *Sender)
{
double x, y;
x=StrToFloat(Edit1->Text);
if(x<=-1) y=2*pow(x,3)+4*x;
if(x>-1 && x<3) y=x+4;
if(x>=3) y=2*x+2;
Memo1->Lines->Add("x="+FloatToStr(x)+
              "  y="+FormatFloat("0.00",y));
}
//-------------------------------------------------------------------------
void __fastcall TForm1::Button2Click(TObject *Sender)
{
Edit1->Clear();
Memo1->Clear();
}
//-------------------------------------------------------------------------
void __fastcall TForm1::Button3Click(TObject *Sender)
{
Close();
}
```

7.4 Example 7.2 - program with branching

The task: Enter the values of parameters and calculate the value of function *y=f(x)*:

$$y = \begin{cases} 7,1x^2 + \dfrac{2,8\sin(c \cdot x)}{2a \cdot b}, & x \le a \\[3mm] \cos^2\left(\dfrac{2a}{3b} + c \cdot x\right), & a < x < b \\[3mm] \sqrt{\left|x + a \cdot c^{0,5}\right|} + \dfrac{a^2}{b}, & x \ge b \end{cases}$$

a = - 5, *b*=5, *c*=2.

The form of the project with results is shown in fig 7.2. The flowchart of button "Calculate" is shown in fig. 7.3.
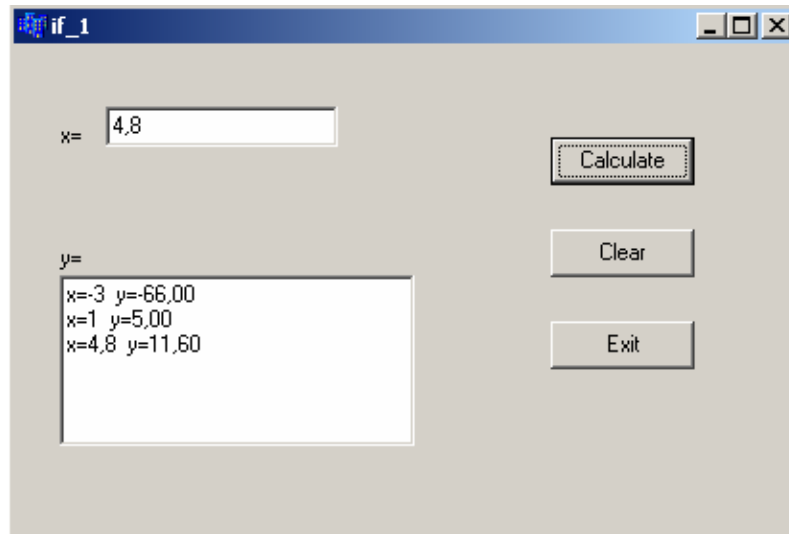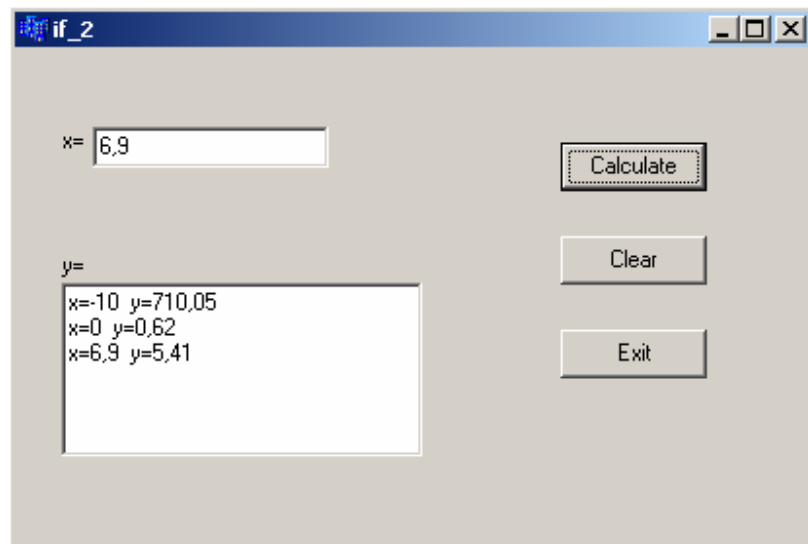

Fig. 7.2 The form of the project and results (example 7.2)

The program:

```
#include <math.h>
…
void __fastcall TForm1::Button1Click(TObject *Sender)
{
const double a=-5, b=5, c=2;
double x, y;
x=StrToFloat(Edit1->Text);
if(x<=a) y=7.1*pow(x,2)+2.8*sin(c*x)/(2*a*b);
if(x>a && x<b) y=pow(cos(2*a/(3*b)+c*x),2);
if(x>=b) y=sqrt(fabs(x+a*pow(c,0.5)))+a*a/b;
Memo1->Lines->Add("x="+FloatToStr(x)+
                 " y="+FormatFloat("0.00",y));
}
```

```
//-------------------------------------------------------------------------
void __fastcall TForm1::Button3Click(TObject *Sender)
{
Close();
}
//-------------------------------------------------------------------------
void __fastcall TForm1::Button2Click(TObject *Sender)
{
Edit1->Clear();
Memo1->Clear();
}
```

```mermaid
```

Begin

Enter x

x<=a

yes — $y = 7{,}1x^2 + \dfrac{2{,}8\sin(c \cdot x)}{2a \cdot b}$

no

a<x<b

yes — $y = \cos^2\left(\dfrac{2a}{3b} + c \cdot x\right)$

no

x>=b

yes — $y = \sqrt{\left|x + a \cdot c^{0.5}\right|} + \dfrac{a^2}{b}$

no

Output y

End
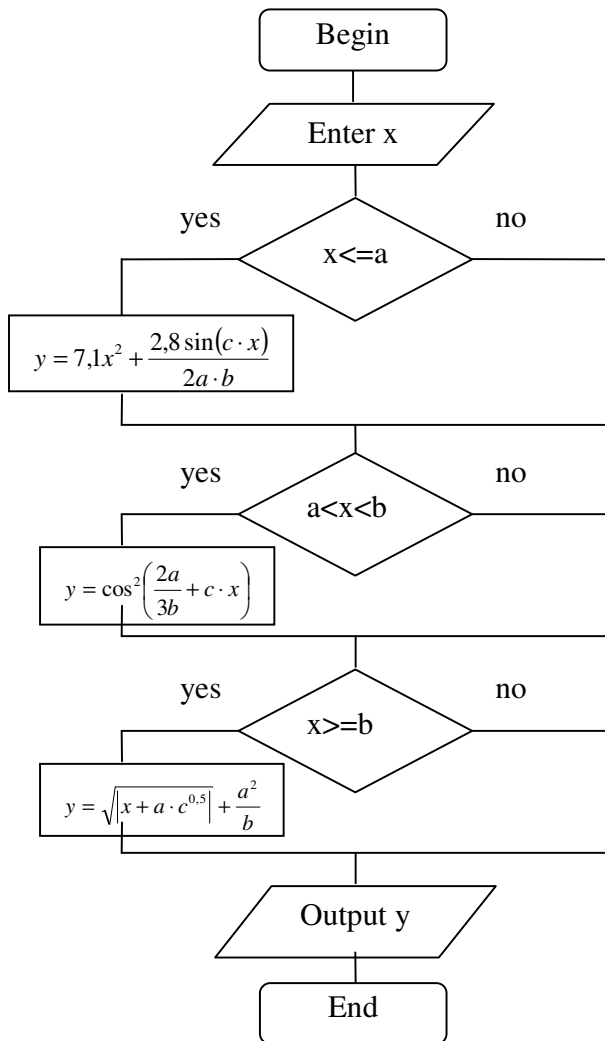
Fig. 7.3 The flowchart of the button "Calculate" (example 7.2)

7.5 Example 7.3 - program with branching

The task: Enter coordinates of the point B (variables x and y) from the screen. Define whether this point lays on the curve:

$$f(x) = \begin{cases} -e^x + x^4 & if\ |x| > 1 \\ \arcsin^2 x - \arccos x^4 & if\ |x| \le 1 \end{cases}$$

An error is `eps=10`$^{-3}$ `(|f(x)-y|<eps)`. Output the answer in the form of the message.

The form of the project is shown in fig. 7.4.

The flowcharts of subroutine and Button1Click function are shown in fig. 7.5 and 7.6:
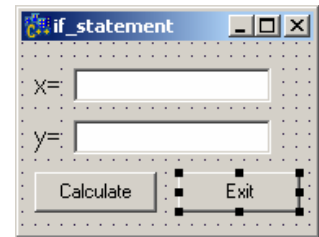
Fig. 7.4 Form of the program
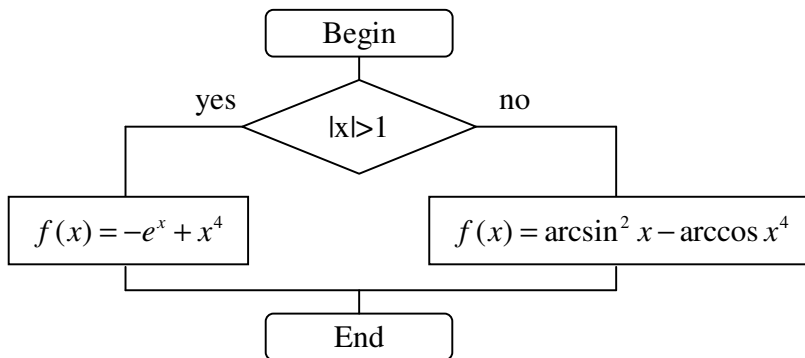
Fig. 7.5 The flowchart of the subroutine of function evaluation
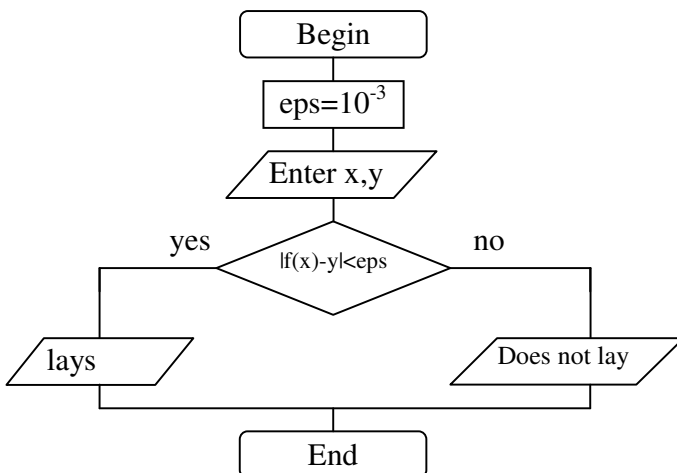
Fig. 7.6 The flowchart of the Button1Click function

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The program code

```
#include <math.h>
...
//subroutine for function f(x) calculation
float f(float x)
{ if (fabs(x)>1) return -exp(x)+pow(x,4);
else  return pow(asin(x),2)-acos(pow(x,4));
}
// "Calculate" button
void __fastcall TForm1::Button1Click(TObject *Sender)
{   const double  eps=1e-3;
    double x,y;
    x=StrToFloat(Edit1->Text);
    y=StrToFloat(Edit2->Text);
    if (fabs(f(x)-y)<eps) ShowMessage("Lays on the curve");
    else  ShowMessage("Does not lay on the curve");
    }
//----------------------------------------------------------------------
void __fastcall TForm1::Button2Click(TObject *Sender)
{
Close();
}
```

7.6 Individual task

Make the flowchart and the project of the program which calculates the values of function **Y=f(x)**, for three variants of function parameters. Functions are set by individual formulas in the tables 7.1, 7.2 and 7.3. Enter the value of **x** from the screen. Output all results on the form.

The additional task: write the same programs in console.

Table 7.1 Variants of functions (low level of complexity)

1	$Y = \begin{cases} 2x+4 & x \le -10 \\ x-4 & , -10 < x < 0 \\ x^3+4 & x \ge 0 \end{cases}$	2	$Y = \begin{cases} 21-x & x \le -7 \\ x^2+3 & , -7 < x < 4 \\ x^2-3 & x \ge 4 \end{cases}$
3	$Y = \begin{cases} x^2+1 & x < 0 \\ x^2-1 & , 0 \le x < 2 \\ x & x > 2 \end{cases}$	4	$Y = \begin{cases} 4x^2+2x & x < -12 \\ 2x-1 & , -12 \le x < 3 \\ x^3+3 & x \ge 3 \end{cases}$
5	$Y = \begin{cases} 2x+2 & x \le -3 \\ 2x-2 & , -3 \le x \le 0 \\ x^2 & x > 0 \end{cases}$	6	$Y = \begin{cases} 3x^2+2x & x < -3 \\ 2x+1 & , -3 \le x < 8 \\ 3x & x \ge 8 \end{cases}$

Continuation of table 7.1 Variants of functions (low level of complexity)

7	$Y = \begin{cases} 6x+8 & x \le -5 \\ x-2 & , \; -5 < x \le 3 \\ 2x^2 & x > 3 \end{cases}$	**8**	$Y = \begin{cases} 4x + 2x & x \le -4 \\ x \_ 2x & , \; -4 < x < 2 \\ x+2 & x \ge 2 \end{cases}$
9	$Y = \begin{cases} 2x-1 & x \le -5 \\ x^2+2 & , \; -5 < x < 5 \\ x+3 & x \ge 5 \end{cases}$	**10**	$Y = \begin{cases} 27x+3 & x \le -6 \\ x^3-1 & , \; -6 < x < 3 \\ x^2+1 & x \ge 3 \end{cases}$
11	$Y = \begin{cases} 6x^3-8 & x \le -8 \\ x^3-8 & , \; -8 < x < 0 \\ 2x^2 & x \ge 0 \end{cases}$	**12**	$Y = \begin{cases} x^3+2x^2 & x \le -2 \\ x^2-1 & , \; -2 < x < 3 \\ 2x+2 & x \ge 3 \end{cases}$
13	$Y = \begin{cases} 2x^3+3x & x \le -1 \\ x^2-4 & , \; -1 \le x < 0 \\ x^3 & x \ge 0 \end{cases}$	**14**	$Y = \begin{cases} 4x^3+2x & x \le -4 \\ 2x-5 & , \; -4 \le x < 4 \\ x-3 & x \ge 4 \end{cases}$
15	$Y = \begin{cases} 4x^2+2x & x \le -12 \\ 2x^2+2x & , \; -12 < x < 3 \\ x+1 & x \ge 3 \end{cases}$	**16**	$Y = \begin{cases} 6x^2+2x & x \le -6 \\ 2x-6 & , \; -6 < x < 4 \\ 6x+1 & x \ge 4 \end{cases}$
17	$Y = \begin{cases} x^3-1 & x \le -4 \\ 2x-1 & , \; -4 < x \le 3 \\ 3x^3 & x > 3 \end{cases}$	**18**	$Y = \begin{cases} 27x^2+1 & x \le -3 \\ x-2 & , \; -3 < x < 5 \\ 3x+1 & x \ge 5 \end{cases}$
19	$Y = \begin{cases} 4x+3 & x \le -6 \\ 2x^3-4 & , \; -6 < x < 6 \\ x^2+1 & x \ge 6 \end{cases}$	**20**	$Y = \begin{cases} 8x^3+2 & x \le -1 \\ x^2-1 & , \; -1 < x < 1 \\ x+1 & x \ge 1 \end{cases}$
21	$Y = \begin{cases} 2x^2+3 & x < -2 \\ x^3-6 & , \; -2 \le x < 0 \\ 2(x+1) & x \ge 0 \end{cases}$	**22**	$Y = \begin{cases} 26x+4 & x \le -6 \\ 4x^2+2 & , \; -6 < x < 6 \\ 2x-3 & x \ge 6 \end{cases}$
23	$Y = \begin{cases} 4x^3+4 & x \le -2 \\ 3x-3 & , \; -2 < x \le 3 \\ 2x_2+2 & x > 3 \end{cases}$	**24**	$Y = \begin{cases} 9x^3+1 & x \le -9 \\ x^2-1 & , \; -9 \le x < 1 \\ x+2 & x > 1 \end{cases}$
25	$Y = \begin{cases} x^3+2x & x \le -8 \\ 2x-1 & , \; -8 < x \le 8 \\ x^2+1 & x > 8 \end{cases}$	**26**	$Y = \begin{cases} 4x^2+4 & x \le -4 \\ x^3-1 & , \; -4 < x < 4 \\ x^2+1 & x \ge 4 \end{cases}$

Continuation of table 7.1 Variants of functions (low level of complexity)

27	$Y = \begin{cases} 25x+1 & x \le -21 \\ x^3-25 & , \; -2 < x < 4 \\ 24x+x^2 & x \ge 4 \end{cases}$	28	$Y = \begin{cases} 2x^3+4x & x \le -1 \\ x+4 & , \; -1 < x < 3 \\ 2x+2 & x \ge 3 \end{cases}$
29	$Y = \begin{cases} x^3-29 & x \le -3 \\ 2x+3 & , \; -3 < x \le 6 \\ x^2+1 & x > 6 \end{cases}$	30	$Y = \begin{cases} 3x+1 & x \le -3 \\ x^2-1, & -3 < x < 4 \\ x^3+1 & x \ge 4 \end{cases}$

Table 7. 2 Variants of functions (medium level of complexity)

№ of var.	Formulas for y	Parameters
1	$y = \begin{cases} 2.5b^2+ax-4.5Cosxz, & x \le 5a \\ \left(a^2-5.4x\right)^3+Ln(xz), & x > b \\ \sqrt{6.5b^2+\left(a-x^3z\right)}, & 5a < x \le b \end{cases}$	$a = 0.5;$ $b = 4.5;$ $z = e^{ax}$
2	$y = \begin{cases} abxCos^2zx, & x < 3{,}5a \\ (a+bx)^2-Ln\lvert(zx)\rvert, & 3{,}5a \le x \le b \\ \sqrt{\left(a+bx-zx^2\right)}, & x > b \end{cases}$	$a = 0.4;$ $b = 2.3;$ $z = e^{2x}$
3	$y = \begin{cases} Sin(bm+Cosnx), & \lvert x \rvert > n^2 \\ Cos(bm-Sinx), & \lvert x \rvert < n^2 \\ \sqrt{e^{\lvert Lnx \rvert}+\sqrt{\lvert bmx \rvert}}, & \lvert x \rvert = n^2 \end{cases}$	$b = -1.6;$ $m = 0.9;$ $n = -1.4$
4	$y = \begin{cases} aSin^2x+bCoszx, & x < -Ln(a) \\ a^b-Cos^3(a+zx), & -Ln(a) < x \le b \\ \sqrt{2.5a^3+\left(b-zx^2\right)^6}, & x > b \end{cases}$	$a = 0.2;$ $b = 0.5;$ $z = e^{ax}$
5	$y = \begin{cases} Sin\left(e^{a+b}\right)+x^2, & e^{ax+b} > e^c \\ arctg(abc)+\sqrt[3]{x}, & e^{ax+b} = e^c \\ Cos\left(\sqrt{\lvert x+abc \rvert}\right), & e^{ax+b} < e^c \end{cases}$	$a = -4{,}2;$ $b = 5.3;$ $c = 1.5$
6	$y = \begin{cases} 7{,}1x^2+\dfrac{2{,}8\sin(c \cdot x)}{2a \cdot b}, & x \le a \\ \cos^2\left(\dfrac{2a}{3b}+c \cdot x\right), & a < x < b \\ \sqrt{\lvert x+a \cdot c^{0,5} \rvert}+\dfrac{a^2}{b}, & x \ge b \end{cases}$	$a = -5;$ $b = 5;$ $c = 2;$

Continuation of the table 7. 2 Variants of functions (medium level of complexity)

№ of var.	Formulas for *y*	Parameters
7	$y = \begin{cases} 2.8 Sin^2 ax - bx^3 z, & x < a \\ zCos(ax+b)^2 + Ln(z), & a \le x \le b^2 \\ e^{2,5ax} + zabx, & x > b^2 \end{cases}$	$a = -5;$ $b = 2.5;$ $z = Ln\left\| bx^3 \right\|$
8	$y = \begin{cases} xe^a + e^{\|bc\|}, & \left\|x - b^2\right\| = a + c \\ Sin^2 ax + Cosbc, & \left\|x - b^2\right\| > a + c \\ \sqrt{ab^4 + \sqrt{cx}}, & \left\|x - b^2\right\| < a + c \end{cases}$	$a = 3.2;$ $b = -0.7;$ $c = 2.2$
9	$y = \begin{cases} Ln\|mx+n\|, & x^2 > m + n \\ e^{Ln\|mx-n\|}, & x^2 = m + n \\ \sqrt[3]{k^2 + Cos^2 x}, & x^2 < m + n \end{cases}$	$k = 3.1;$ $m = 5.15;$ $n = -0.5$
10	$y = \begin{cases} aSin^{2.5} x + bCos(zx+a), & x < a^3 \\ (a+bx)^2 - Sin(a+zx), & a^3 \le x \le b \\ \sqrt{(Sin(a+bx+z)-x)}, & x > b \end{cases}$	$a = -2.2;$ $b = 7.2;$ $z = e^x$
11	$y = \begin{cases} \sqrt[3]{b^2 + \sqrt{\|x+c\|}}, & Lga + Lgb < Lgc \\ Cos(x-a+b-c), & Lga + Lgb = Lgc \\ Sin(x+a-b+c), & Lga + Lgb > Lgc \end{cases}$	$a = 101;$ $b = 9;$ $c = 1112$
12	$y = \begin{cases} e^{ax} - 3.5 Cos^2(z+bx), & x \le a \\ a + Ln\|a+bx\| - 2x, & a < x \le b^{3.5} \\ a + Cos^{3.5}(a+bxz), & x > b^{3.5} \end{cases}$	$a = -1;$ $b = 3.4;$ $z = tgbx$
13	$y = \begin{cases} Ln(Lg\|kx+mn\|), & 3kx > \|m+n\| \\ Sinkmx + \sqrt{\|nx\|}, & 3kx = \|m+n\| \\ e^{kCosx} + e^{m+n}, & 3kx < \|m+n\| \end{cases}$	$k = 4;$ $m = -14.7;$ $n = -0.7$
14	$y = \begin{cases} x^2 e^{2k} + Ln\|rx\|, & Cosx = Cosrs \\ \sqrt[3]{x^2} + \left\|\sqrt{k+rsx}\right\|, & Cosx > Cosrs \\ arctg(kx+rs), & Cosx < Cosrs \end{cases}$	$k = 1.33;$ $r = 0.85;$ $s = 3,5$
15	$y = \begin{cases} \sqrt{ax - Cos^2 b^3 x + 5.1c^2}, & \left\|x - b^2\right\| = a + c \\ e^{0.007x} + Ln\|b^5 C"sx\|, & \left\|x - b^2\right\| > a + c \\ Cos^2 b^3 x^2 + Ln\|bx - a^2\|, & \left\|x - b^2\right\| < a + c \end{cases}$	$a = 3.5;$ $b = -0.73;$ $c = 2.5$

Continuation of the table 7. 2 Variants of functions (medium level of complexity)

№ of var.	Formulas for y	Parameters
16	$y = \begin{cases} 3.5 Sin(bx+z) - e^{3.5a}, & x \le a \\ Ln(a+b^3x)+a, & a < x \le b^{2.5} \\ Cos^2(a^b+xz)+a^2, & x > b^{2.5} \end{cases}$	$a = 0.2;$ $b = 0.5;$ $z = e^{2.5ax}$
17	$y = \begin{cases} a + Sinbx + Cosx^2, & x < a \\ \sqrt{a+bx} + Sinzx, & a < x < Lnb \\ Ln(a+bx+z), & x > Lnb \end{cases}$	$a = 0.2;$ $b = 0.75;$ $z = Ln(bx)$
18	$y = \begin{cases} (3.5a - 7.3bx + Sinzx), & x < -Ln|a| \\ a^b - Cos^3(a+zx), & -Ln|a| \le x < b \\ \sqrt{|tga-x|} - x^2, & x > b \end{cases}$	$a = 6;$ $b = 3.2;$ $z = e^{1.5ax}$
19	$y = \begin{cases} cSinb^2x + bLn(cx+a), & x \le a \\ a + Ln(bx) - Sin^2(a+cx), & a \le x < b \\ \sqrt{Cos(a+bx)+cx^2}, & x > b \end{cases}$	$a = 2.2;$ $b = 2.4;$ $c = Ln|bx|$
20	$y = \begin{cases} e^{ax} + fCos^{3.5}bx, & x \le a \\ a + Cos^2bx - Ln(fx), & a \le x < b^2 \\ Cos^2(a+bfx), & x > b^2 \end{cases}$	$a = 0.8;$ $b = 2.4;$ $f = e^{1.5ax}$
21	$y = \begin{cases} a + bx + Sin^2zx^{3.5}, & x < a \\ a + Ln|ab - zx^3| + Lnx, & a \le x \le b^2 \\ \sqrt{|a+tgzx|} + bSinx, & x > b^2 \end{cases}$	$a = 0.3;$ $b = 0.9;$ $z = Sinx^2$
22	$y = \begin{cases} Ln|bzx| + za^{2.5}, & a^5 < x \le b \\ ax^2 + bz^a + Sin^2zx, & x > b \\ Cos(ax+b) + Ln|zx|, & x \le a^5 \end{cases}$	$a = 1.5;$ $b = 6.4;$ $z = Ln|bx^3|$
23	$y = \begin{cases} a \cdot sin^2 x + ln|b \cdot c \cdot x^2|, & x < \dfrac{\pi}{2} \\ sin^2(x^3 + 3a + \sqrt{b \cdot c}), & x = \dfrac{\pi}{2} \\ cos(x/a) + b\sqrt{c}, & x > \dfrac{\pi}{2} \end{cases}$	$a = 5;$ $b = 5;$ $c = 10$

Continuation of the table 7. 2 Variants of functions (medium level of complexity)

№ of var.	Formulas for y	Parameters
24	$y = \begin{cases} c \cdot a^2 + b \cdot \cos^3(a \cdot x), & a > x \\ \ln|a \cdot c \cdot x| + \sqrt{b}, & a \le xb \\ \cos(a + b \cdot x \cdot c + a \cdot c^2), & x > b \end{cases}$	$a = 0.5;$ $b = 6;$ $c = -5$
25	$y = \begin{cases} a^2 + \sqrt{b^4 + 1.7}, & |Cosx| < 0.2 \\ arctg(2^x - |p|), & |Cosx| = 0.2 \\ \sqrt[3]{Ln|a|} + 4.3, & |Cosx| > 0.2 \end{cases}$	$a = 0.5;$ $b = 1.5;$ $p = -4$
26	$y = \begin{cases} a + z \cos^2 bx^3, & x < a \\ a + Sin^2 b^2 + Ln(zx), & a < x < b \\ \sqrt[3]{0.3b + \sqrt{|(a - z^2 - \cos x)|}}, & x > b \end{cases}$	$a = 1.5;$ $b = 5.7;$ $z = Ln|tg\ bx|$
27	$y = \begin{cases} a \cdot x - b^2 + a \cdot \cos(c \cdot x), & x < a \\ c(a + b \cdot x) + \cos(b \cdot x), & x = a \\ a \cdot x^b + e^{c \cdot x} + \sin^2 x, & x > b \end{cases}$	$a = 1,4$ $.b = 1,7$ $c = 3,7$
28	$y = \begin{cases} xe^x + (z + 7.7abx), & x < a \\ tg(ax + z) + Cos^2 bx, & a \le x \le b^2 \\ Ln(Sin(a + bx + zx^2)), & x > b^2 \end{cases}$	$a = 3.7;$ $b = 8.7;$ $z = tgbx$
29	$y = \begin{cases} 2u + \sqrt[3]{a \cdot c}, & u \le a - c^2 \\ \ln(a \cdot c) + Cos^2 u, & u > a - c^2 \end{cases}$	$a = 3.6;$ $c = 2.1;$ $u = Sinx$

Table 7.3 Variants of the individual task (medium level of complexity)

№ var.	Individual task
1.	Enter two numbers from the screen. What is bigger: the sum of squares or half of the squared sum of these numbers? Output the answer in the form of the message.
2.	Enter from the screen the radian measure of the angle. What is bigger: the value of sine or the value of cosine of this angle? Output the answer in the form of the message.
3.	Enter three numbers from the screen. Output the number, which value is between two other.
4.	Enter three numbers from the screen. Raise positive of these numbers in the third power and substitute negative on 0.

Continuation of the table 7.3 Variants of the individual task

№ var	Individual task
5.	Enter from the screen coordinates of point B (variables x and y). Define, whether this point lays on the curve $f(x)=6x^7-4.5x^5+4x^2$. Output the answer in the form of the message.
6.	Enter coordinates of points A(x0, y0) and B(x1, y1) from the screen. Define which of points A or B is more remote from the origin of coordinates (O(0,0)). Output the answer in the form of the message.
7.	Enter three triangle's sides a, b and c from the screen and define, whether the triangle is rectangular. Output the answer in the form of the message.
8.	Enter coordinates of point A (variables x and y) from the screen. In what coordinate quarter does this point lay? Output the answer in the form of the message.
9.	Enter coordinates of a point (variables x and y) from the screen. Does this point lay inside the circle with the radius R? The center of the circle is the origin of coordinates. Output the answer in the form of the message.
10.	Enter three numbers from the screen. Square positive of them, and negative leave without changes.
11.	Enter from the screen three numbers (sides of triangle). Define, is it possible to make a triangle with these sides. An answer output in the form of the message.
12.	Enter sides of two triangles $a1$, $b1$, $c1$ and $a2$, $b2$, $c2$ from the screen. What triangle has a bigger square? Output the answer in the form of the message.
13.	Calculate the squares of a square with the side a and a circle with radius R. What figure has a bigger square? Values of a and R enter from the screen. Output the answer in the form of the message.
14.	Enter coordinates of point B (variables x and y) from the screen. Does this point lay on the curve $f(x)=6\cos2x -0{,}25x^5+3.2x^2-2.7$? An error is eps=$10^{-3}$ (|f(x)-y|<eps). Output the answer in the form of the message.
15.	Enter three numbers from the screen. Output the biggest of them on the form.
16.	Enter three sides of the triangle a, b, and c from the screen. The smallest of them is a side of a square. Which of the figures (the triangle or the square) has the bigger square? Output the answer in the form of the message.
17.	Enter coordinates of point Q (variables x and y) from the screen. Does the point lay on the line $f(x)=7\operatorname{tg}2x-0{,}31x^3+3.2x^2-e^x$? An error is eps=$10^{-3}$ (|f(x)-y|<eps). Output the answer in the form of the message.
18.	Enter coordinates of point B (variables x and y) from the screen. Does the point lay on the curve $f(x)=\begin{cases}\sin^2 x^3 & if\ |x|>1 \\ \sqrt{6\arcsin x^7 + 4.5x^6 + 4x^2 + 2} & if\ |x|\le 1\end{cases}$. An error is eps=$10^{-3}$ (т.е. |f(x)-y|<eps). Output the answer in the form of the message.

Continuation of the table 7.3 Variants of the individual task

№ var	Individual task
19.	Enter coordinates of the point *A* (variables *x* and *y*) from the screen. Does the point lie in the first coordinate quarter? Output the answer in the form of the message.
20.	Enter three numbers from the screen. Output the numbers which absolute value is bigger than arithmetic average of these numbers.
21.	Enter a radian measure of an angle from the screen. What is bigger: the tangent or cotangent of this angle? Output the answer in the form of the message.
22.	Enter two numbers from the screen. What is bigger: the difference of their squares or the sum of these numbers? Output the answer in the form of the message.
23.	Enter coordinates of points *A(x0, y0)* and *B(x1, y1)* from the screen. What point is allocated more close from the origin of coordinates (O(0,0))? Output the answer in the form of the message.
24.	Enter three numbers from the screen. Output the smaller of them on the form.
25.	Enter coordinates of point *A* (variables *x* and *y*) from the screen. Does this point lay inside the torus, limited by circles with radiuses *R* and *r* with centre in a point O(0,0). Output the answer in the form of the message. *R* and *r* are constants.
26.	Enter coordinates of point *A* (variables *x* and *y*) from the screen. Does the point lie in the fourth coordinate quarter? Output the answer in the form of the message.
27.	Enter three triangle's sides *a, b* and *c.* Is this triangle isosceles? Output the answer in the form of the message.
28.	Enter three integer numbers from the screen (*a, b, c*). Are they triple of Pifagor ($c^2 = a^2 + в^2$)? Output the answer in the form of the message.
29.	Enter coordinates of the point *A* (variables *x* and *y*) from the screen. Does the point lay in the field, limited with parabola $y=2 - x^2$ and abscissa axis? Output the answer in the form of the message.
30.	Enter coordinates of three points $A_1(x_1, y_1)$, $A_2(x_2, y_2)$, $A_3(x_3, y_3)$ from the screen. Do these points lie on one line? Output the answer in the form of the message.

Laboratory work 1.8 Switch statement

The purpose is to get acquaintance to switch statement, get practical skills in writing programs with switch statement.

8.1 Control questions

1. What is the syntax of the `switch` statement?
2. What is the flowchart of the `switch` statement?
3. Is it necessary to write `break` in the `switch` statement? Why?
4. Can we write `if` instead of `switch`? How?

8.2 Theoretical information

A **switch** statement is used in place of many **if** statements. A switch statement allows a programmer to select the value of expression from one of several **integer values** and then do actions accordingly. The switch statement has the syntax:

```
switch(expression){
    case constant1: action_1; break;
    case constant2: action_2; break;
     ...
    case constantn: action_n; break;
    default: action_n+1; //code to execute if expression is none of the above
}
```

The first *expression* (called the switch **tag**) is evaluated, and the outcome is compared to each of the numeric *constant*s (called case **labels**), in the order they appear, until a match is found. The *statements* following the matching case are then executed. Each case may be followed by zero or more statements (not just one statement). Execution continues until either a break statement is encountered or all statements until the end of the switch statement are executed. The final default case is optional and is exercised if none of the earlier cases provide a match.

Example. Enter number of the week day and show the message with its name (1-Monday, 2 – Tuesday and so on).

Fragment of the program:

```
int n=StrToInt(Edit1->Text);
switch (n){
    case 1: ShowMessage ("Monday"); break;
    case 2: ShowMessage ("Tuesday"); break;
    case 3: ShowMessage ("Wednesday"); break;
    case 4: ShowMessage ("Thursday"); break;
    case 5: ShowMessage ("Friday"); break;
    case 6: ShowMessage ("Saturday"); break;
    case 7: ShowMessage ("Sunday"); break;
    default: ShowMessage ("The number is not correct"); break;
}
```

Note that each case ends with break operator. It stops execution of the program block. In this example if we have found necessary case (2), break will prevent us from checking of other cases.

Example 8.1 – a project with switch

Make a flowchart and a project of the program which calculates the values of function *y=f(x)* for three variants of parameters' values under the given formulas.

User must enter *x* and the choice *n* (integer numbers 1, 2 or 3). Variables *a*, *b*, and *z* must be calculated in dependence on this choice. When the values of *a*, *b*, *z* are defined, the program calculates the value of *y*.

$$
y = \begin{cases}
a^5 + arctg\left(\cos^2(a+b)x\right) + \sqrt{\sin^{-2} x}, & \text{if} \quad x \le a \\
\sqrt{\left(a^3 - bx\right)^2 + 7} + \cos^3 zx, & \text{if} \quad a < x < \ln b \\
\left|\ln|a + bx + zx^2|\right|, & \text{if} \quad x \ge \ln b
\end{cases}
$$

1. $a = 1.3;\ b = 4.9;\ z = \sin|tg(bx)|$
2. $a = 8.9;\ b = 6.4;\ z = tg|\sin(bx)|$
3. $a = -4.1;\ b = 5.3;\ z = \cos|tg(bx)|$

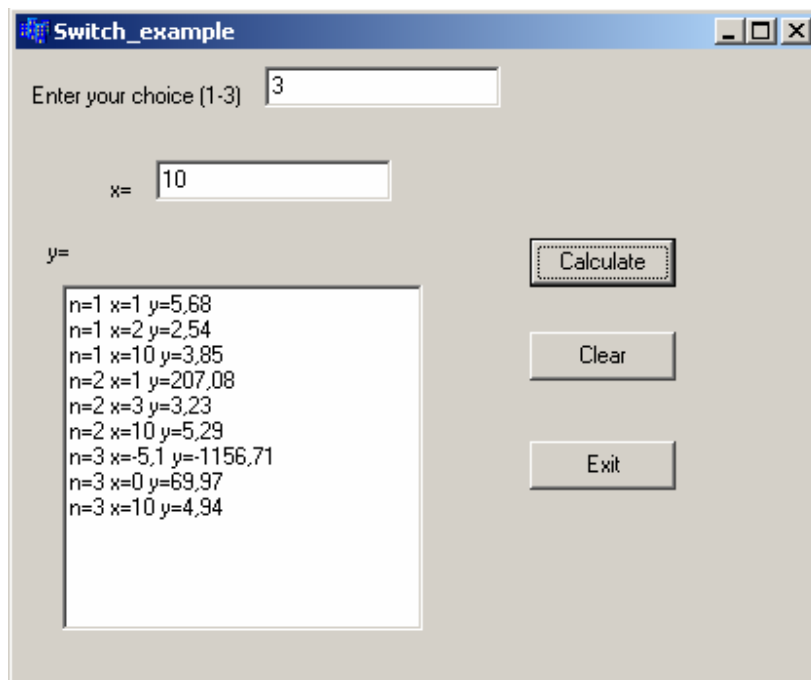The form of the project with results is shown in fig. 8.1:

Fig. 8.1 form with results

The code of the program:

I method (with function which calculates y)

```
#include <math.h>
……
//-------------------------------------------------------------------------
void __fastcall TForm1::Button2Click(TObject *Sender)
{
Edit1->Clear();
Memo1->Clear();
}
//-------------------------------------------------------------------------
// function func definition
double func(double x, double a, double b, double z)
{
double y;
if (x<=a)
    y=pow(a,5)+atan(pow(cos((a+b)*x),2))+sqrt(pow(sin(x),-2));
else
    if (x<=log(b))
        y=sqrt(pow(pow(a,3)-b*x,2)+7)+pow(cos(z*x),3);
    else
        y=log(fabs(a+b*x+z*x*x));
return y;
}
//Button1
void __fastcall TForm1::Button1Click(TObject *Sender)
{
int n;
double x,Y,a,b,z;
x=StrToFloat(Edit2->Text);
n=StrToInt(Edit1->Text);
//calculation of a, b, z in dependence on the choice of n
switch(n){
    case 1:  a=1.3; b=4.9; z=sin(fabs(tan(b*x))); break;
    case 2:  a=2.9; b=6.4; z=tan(fabs(sin(b*x))); break;
    case 3:  a=-4.1; b=5.3; z=cos(fabs(tan(b*x))); break;
    default: ShowMessage("The choice is not correct");
}
Y=func(x, a, b,z);          //call of function func
Memo1->Lines->Add("n="+IntToStr(n)+"x="+FloatToStr(x)+
            " y="+FormatFloat("0.00",Y));
}
```

The flowchart of subroutine is shown in fig. 8.2 and the flowchart of the program is shown in fig. 8.3:
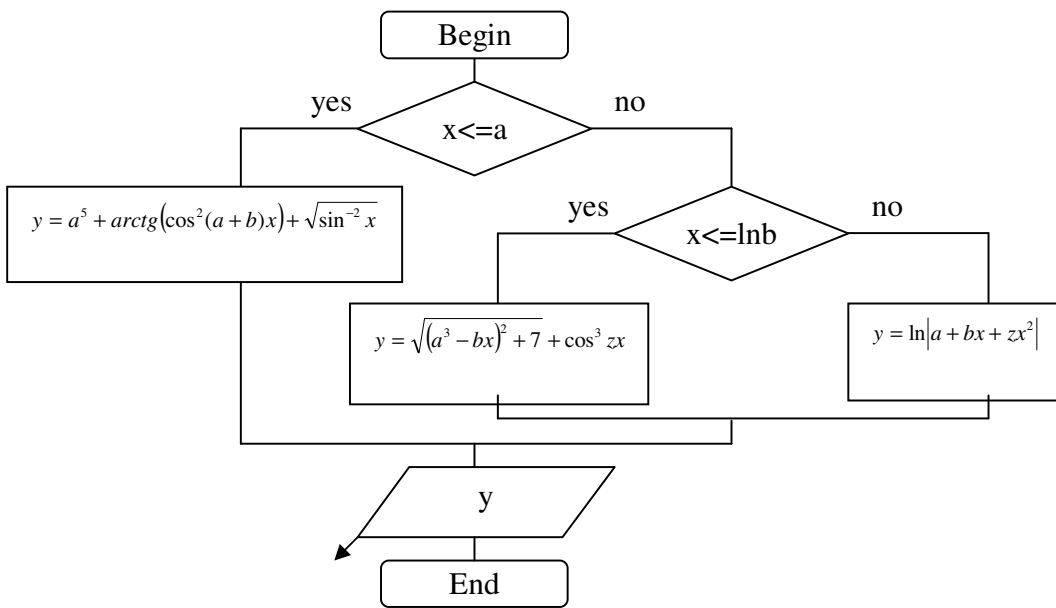
Fig. 8.2 The flowchart of the subroutine (function evaluation)

Begin

Enter x

Enter n

n

| a=1.3 | a=2.9 | a=-4.1 | The choice is not correct |

| b=4.9 | b=6.4 | b=5.3 |

| z=sin(fabs(tan(b*x))) | z=tan(fabs(sin(b*x))) | z=cos(fabs(tan(b*x))) |

Y=func(x, a, b,z);

Y

End
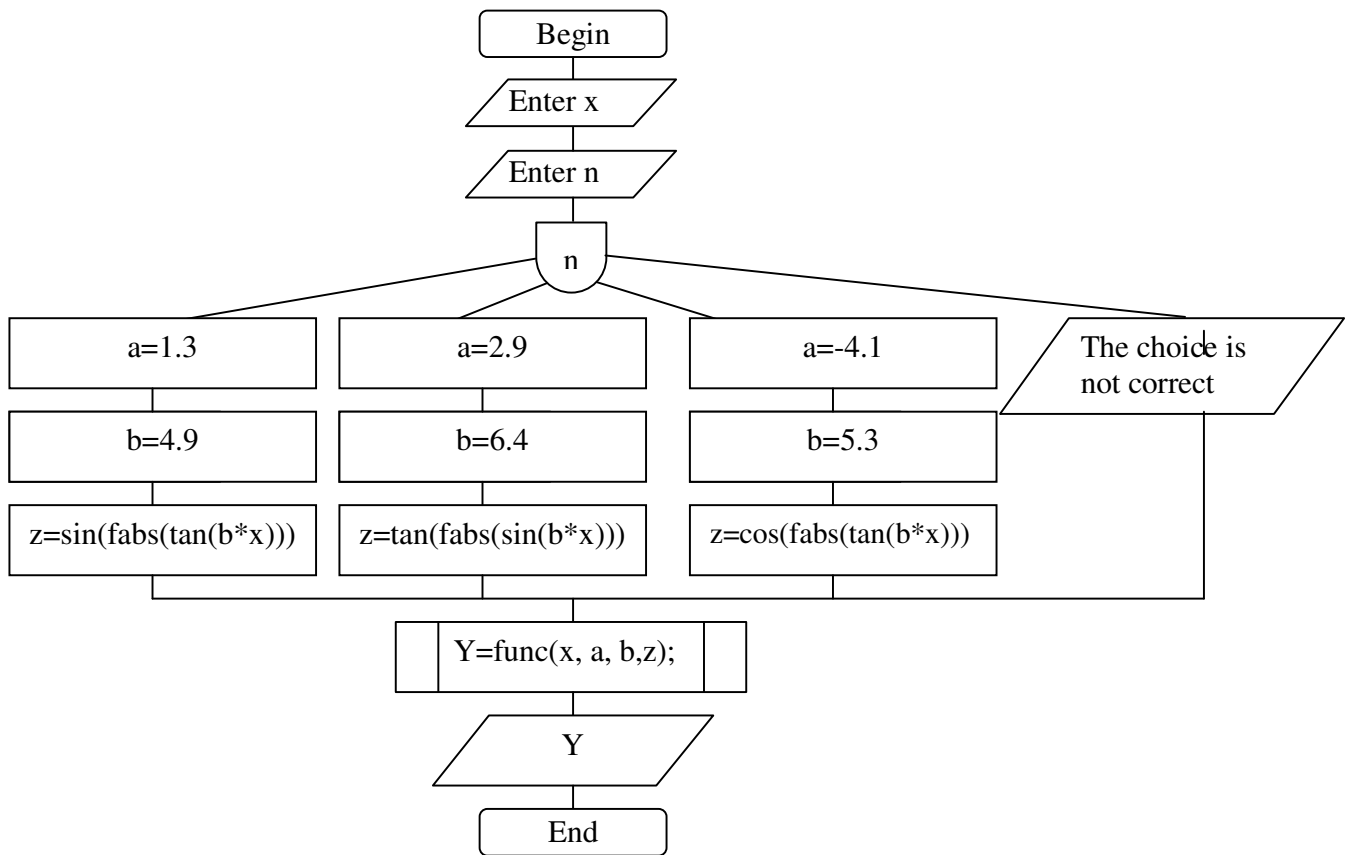
Fig. 8.3 The flowchart of the Button1Click function

II method (without function which calculates y)

```
#include <math.h>
……
//-------------------------------------------------------------------------
void __fastcall TForm1::Button1Click(TObject *Sender)
{
int n;
double x,y,a,b,z;
x=StrToFloat(Edit2->Text);
n=StrToInt(Edit1->Text);
```
//calculation of a, b, z in dependence on the choice n
```
switch(n){
    case 1:  a=1.3; b=4.9; z=sin(fabs(tan(b*x))); break;
    case 2:  a=2.9; b=6.4; z=tan(fabs(sin(b*x))); break;
    case 3:  a=-4.1; b=5.3; z=cos(fabs(tan(b*x))); break;
    default: ShowMessage("The choice is not correct");
}
```
//calculation of y
```
if (x<=a)
    y=pow(a,5)+atan(pow(cos((a+b)*x),2))+sqrt(pow(sin(x),-2));
else
    if (x<=log(b))
        y=sqrt(pow(pow(a,3)-b*x,2)+7)+pow(cos(z*x),3);
    else
        y=log(fabs(a+b*x+z*x*x));
Memo1->Lines->Add("n="+IntToStr(n)+" x="+FloatToStr(x)+
                    " y="+FormatFloat("0.00",y));
}
```

Structure flowchart of the program is shown in fig. 8.4:

Fig. 8.4 The flowchart of the program

Individual task

Make a flowchart and a project of the program which calculates the values of function **Y** for three variants of parameters values under the given formulas (table 8.1).

Table 8.1 Variants of the individual tasks
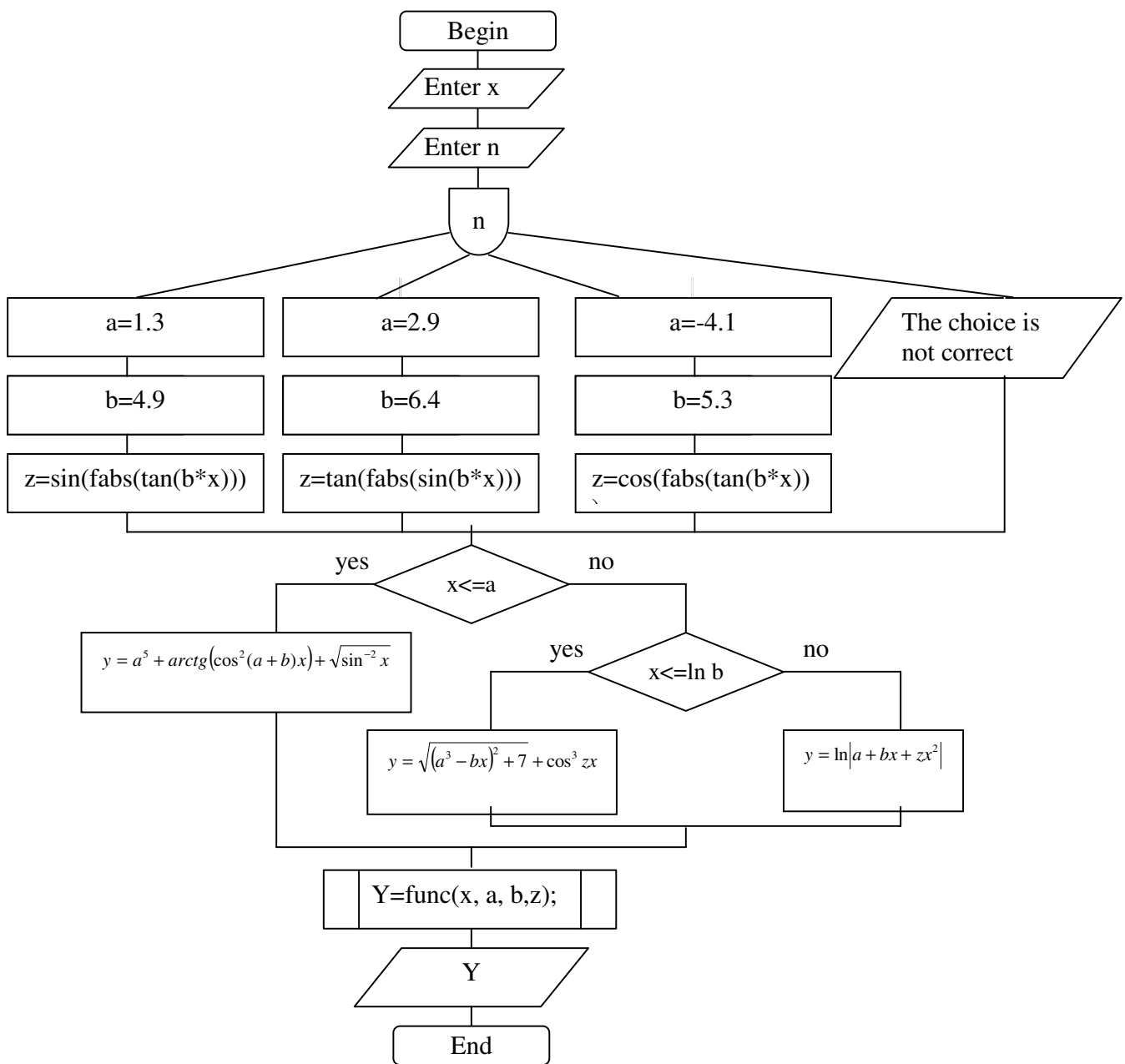
№ of var	Formulas	Values of parameters
1	$y = \begin{cases} \dfrac{(2u+1)^2}{7\pi+x}, & \text{if} \quad u+x > -0.5 \\[2mm] \cos^2 u - \sin\dfrac{u}{3}, & \text{if} \ -0.5 \le u+x \le 10^{-3} \\[2mm] \dfrac{\lg(u+x)-e^x}{3.5x} & \text{if} \quad u+x > 10^{-3} \end{cases}$	1. $u = \sin x$ 2. $u = \cos x$ 3. $u = tgx$
2	$y = \begin{cases} abx - \cos^2(zx), & \text{if} \quad x < 3.5a \\ (a-x)^2 - \ln(z+x), & \text{if} \ 3.5a \le x \le b \\ \sqrt{bx - a + zx^2}, & \text{if} \quad x > b \end{cases}$	1. $a = 0.4;\ b = 2.3;\ z = e^{2x}$ 2. $a = 0.2;\ b = 0.8;\ z = e^x$ 3. $a = 0.7;\ b = 8.1;\ z = 0.8$
3	$y = \begin{cases} \sin(bm + \cos(nx)), & \text{if} \quad |bm| > x^2 \\ \cos(bm - \sin x), & \text{if} \quad |bm| < x^2 \\ \sqrt{e^{|\cos x|} + \sqrt{|bmx|}}, & \text{if} \quad |bm| = x^2 \end{cases}$	1. $b = -1.6;\ m = 0.9;\ n = -1.4$ 2. $b = 4.5;\ m = -2;\ n = 2.2$ 3. $b = -4.5;\ m = 0.5;\ n = -1.5$
4	$y = \begin{cases} a\sin^2 x + b\cos(zx), & \text{if} \ x < -\ln(a) \\ a^b - \cos^3(a+zx), & \text{if} \ -\ln(a) \le x \le b \\ \sqrt{2.5a^3 + (b - zx^2)^6}, & \text{if} \quad x > b \end{cases}$	1. $a = 0.2;\ b = 0.5;\ z = e^{ax}$ 2. $a = 0.15;\ b = 0.2;\ z = e^{2ax}$ 3. $a = 0.9;\ b = 5;\ z = e^{2.5ax}$
5	$y = \begin{cases} \sin(e^{a+b}) + x^2, & \text{if} \quad e^{a+b} > e^x \\ arctg(abc) + \sqrt[3]{x}, & \text{if} \quad e^{a+b} = e^x \\ \cos(\sqrt{|x + abc|}), & \text{if} \quad e^{a+b} < e^x \end{cases}$	1. $a = 4{,}2;\ b = 5.3;\ c = 1.5$ 2. $a = -0.35;\ b = 1.8;\ c = -1.8$ 3. $a = 2.8;\ b = -0.6;\ c = 2.0$
6	$y = \begin{cases} 2.8\sin^2 ax - bx^3 z, & \text{if} \ x < a \\ z\cos(ax+b)^2 + \ln(z), & \text{if} \ a \le x \le b^2 \\ e^{2,5ax} + zabx, & \text{if} \quad x > b^2 \end{cases}$	1. $a = -5;\ b = 2.5;\ z = \ln|bx^3|$ 2. $a = 3;\ b = 5;\ z = \ln|bx|$ 3. $a = -10;\ b = 3;\ z = \ln|bx^2|$
7	$y = \begin{cases} xe^a + e^{|bc|}, & \text{if} \ |1 - x^2| = a + c \\ \sin^2 ax + \cos bc, & \text{if} \ |1 - x^2| > a + c \\ \sqrt{ab^4 + \sqrt[5]{cx^2}}, & \text{if} \ |1 - x^2| < a + c \end{cases}$	1. $a = 3.2;\ b = -0.7;\ c = 2.2$ 2. $a = 10.5;\ b = -2.5;\ c = 5.6$ 3. $a = 5.4;\ b = 3;\ c = 2.6$
8	$y = \begin{cases} \ln|mx + n|, & \text{if} \ x^2 > m + n \\ e^{\cos|mx - n|}, & \text{if} \ x^2 = m + n \\ \sqrt[3]{k^2 + \cos^2 x}, & \text{if} \ x^2 < m + n \end{cases}$	1. $k = 3.1;\ m = 5.15;\ n = -1.15$ 2. $k = 0.78;\ m = -2.4;\ n = 4.36$ 3. $k = 1.1;\ m = 0.8;\ n = 0.41$

Continuation of the table 8.1 Variants of the individual tasks

№ of var	Formulas	Values of parameters
9	$y = \begin{cases} a\sin^2 x + b\cos(zx+a), & \text{if } \quad x < a^3 \\ (a+bx)^2 - \sin(a+zx), & \text{if } \quad a^3 \le x \le b \\ \sqrt{x-(\sin(bx+z))}, & \text{if } \qquad x > b \end{cases}$	1. $a = 1.2;\ b = 7.2;\quad z = e^x$ 2. $a = -1.5;\ b = 3.2;\ z = e^{2x}$ 3. $a = 1.7;\quad b = 5.5;\ z = e^3$
10	$y = \begin{cases} \sqrt[3]{b^2 + \sqrt{|x+c|}}, & \text{if } \quad \lg a < x \\ \cos(x-b-c), & \text{if } \quad \lg a = x \\ \sin(x+a-b), & \text{if } \quad \lg a > x \end{cases}$	1. $a = 0.1;\quad b = 9.8;\quad c = 11.12$ 2. $a = 10;\quad b = 10.05;\ c = 6.2$ 3. $a = 100;\ b = 3.03;\quad c = 7.12$
11	$y = \begin{cases} e^{ax} - 3.5\cos^2(z+bx), & \text{if } x \le a \\ a + \ln|a+bx| - 2x, & \text{if } a < x \le b^{3.5} \\ a + \cos^{3.5}(a+bxz), & \text{if } x > b^{3.5} \end{cases}$	1. $a=-1; b=3.4; z=tgbx$ 2. $a=-3.2; b=5.5; z=tgbx^2$ 3. $a=-5.2; b=7.2; z=tgbx^3$
12	$y = \begin{cases} \ln(|\lg|kx+mn||), & \text{if } 3x > |m+n| \\ \sin(kmx) + \sqrt{|nx|}, & \text{if } 3x = |m+n| \\ e^{\cos x} + e^{m+n}, & \text{if } 3x < |m+n| \end{cases}$	1. $k=4;\ m=-14.7;\ n=-0.6$ 2. $k=3;\ m=6.5;\quad n=3.15$ 3. $k=5;\quad m=-12;\ n=0.45$
13	$y = \begin{cases} x^2 e^{2k} + \ln|rx|, & \text{if } \cos x = \cos(rs) \\ \sqrt[3]{x^2} + \sqrt{|k+rsx|}, & \text{if } \cos x > \cos(rs) \\ arctg(kx+rs), & \text{if } \cos x < \cos(rs) \end{cases}$	1. $k=1.33;\ r=0.85;\ s=3,5$ 2. $k=0.9;\ r=3,3;\quad s=1.2$ 3. $k=1.57;\ r=0.75;\ s=2.15$
14	$y = \begin{cases} 2.5b^2 + ax - 4.5\cos xz, & \text{if } x \le 5a \\ (a^2 - 5.4x)^3 + \ln(xz), & \text{if } \quad x > b \\ \sqrt{6.5b^2 + (a - x^3 z)}, & \text{if } \quad 5a < x \le b \end{cases}$	1. $a = 0.5;\quad b = 4.5;\quad z = e^{ax}$ 2. $a = 0.5;\quad b = 3.7;\quad z = e^{2ax}$ 3. $a = 0,5;\quad b = 2.7;\quad z = e^{2.5ax}$
15	$y = \begin{cases} \sqrt{|ax - \cos^2 b^3 x + 5.1c^2|}, & \text{if } |1-x^2| = a+c \\ e^{0.04x} + \ln|b^5 \cos x|, & \text{if } |1-x^2| > a+c \\ \cos^2(b^3 x^2) + \ln|bx - a^2|, & \text{if } |1-x^2| < a+c \end{cases}$	1. $a=3.5;\ b=-0.73;\ c=2.5$ 2. $a=15,4;\ b=-5.6;\ c=3.5$ 3. $a=5.1;\quad b=4;\quad c=2.7$
16	$y = \begin{cases} 3.5\sin^2(bx+z)^3 - e^{3.5a}, & \text{if } \quad x \le a \\ \ln(a + b^3 x) + a, & \text{if } a < x \le b^{2.5} \\ \cos^2(a^b + xz) + a^2, & \text{if } \quad x > b^{2.5} \end{cases}$	1. $a = 0.1;\ b = 0.5;\quad z = e^{2.5ax}$ 2. $a = 1.2;\ b = 2.5;\quad z = e^{2.5ax}$ 3. $a = 2.5;\ b = 1.2;\quad z = e^{2.5ax}$

Continuation of the table 8.1 Variants of the individual tasks

№ of var	Formulas	Values of parameters
17	$y = \begin{cases} a + \sin bx + \cos x^2, & \text{if } x \le a \\ \sqrt{a + bx} + \sin zx, & \text{if } a < x < \ln b \\ \ln(a + bx + z), & \text{if } x \ge \ln b \end{cases}$	1. $a = -1.2;\ b = 0.75;\ z = \ln(tg(bx))$ 2. $a = 0.4;\quad b = 2.4;\ z = \ln(tg(bx))$ 3. $a = 1.1;\quad b = 6.1;\quad z = \ln(tg(bx))$
18	$y = \begin{cases} (3.5a - 7.3bx + \sin(zx))^3, & \text{if } x < -\ln|a| \\ a^b - \cos^3(a + zx), & \text{if } -\ln|a| \le x < b \\ \sqrt{|tga - x|} - x^2, & \text{if } x > b \end{cases}$	1. $a = 6;\quad b = 3.2;\ z = e^{1.5ax}$ 2. $a = 3;\quad b = 6;\quad z = e^{1.5ax}$ 3. $a = 2.7;\ b = 1.8;\ z = e^{1.5ax}$
19	$y = \begin{cases} c \sin(b^2 x) + b \ln(cx + a), & \text{if } x < a \\ a + \ln(bx) - \sin^2(a + cx), & \text{if } a \le x < b \\ \sqrt{|\cos(a + bx) + cx^2|}, & \text{if } x \ge b \end{cases}$	1. $a = 2.2;\ b = 2.4;\ c = \ln|bx|$ 2. $a = 1.6;\ b = 1.7;\ c = \ln|bx|$ 3. $a = 1.3;\ b = 4.2;\ c = \ln|b^2 x|$
20	$y = \begin{cases} e^{ax} + f \cos^5 bx, & \text{if } x \le a \\ a + \cos^2 bx - \ln(fx), & \text{if } a < x \le b^2 \\ \cos^2(a + bfx), & \text{if } x > b^2 \end{cases}$	1. $a = 0.8;\ b = 2.4;\ f = e^{1.5ax}$ 2. $a = 1.2;\ b = 4.2;\ f = e^{2ax}$ 3. $a = 3.4;\ b = 8.1;\ f = e^{3ax}$
21	$y = \begin{cases} asos^2 x + b \sin zx, & \text{if } x \le a \\ a\,tg(ax + z) + \sin^2 bx, & \text{if } a < x \le 4.5b \\ \ln(ax - b) + z^2, & \text{if } x > 4.5b \end{cases}$	1. $a = 4.5;\ b = 8.4;\ z = tg(bx)^2$ 2. $a = 8.2;\ b = 15.2;\ z = tg(bx)^2$ 3. $a = 1.7;\ b = 0.5;\ z = tg(bx^2)$
22	$y = \begin{cases} a + bx + \sin^2 zx^{3.5}, & \text{if } x < a \\ a + \ln|ab - zx^3| + \ln x, & \text{if } a \le x \le b^2 \\ \sqrt{|a + ctg(zx)|} + b \sin x, & \text{if } x > b^2 \end{cases}$	1. $a = 0.3;\ b = 0.9;\ z = \sin x^2$ 2. $a = 4.3;\ b = 3.15;\ z = \sin x^3$ 3. $a = 6.5;\ b = 3.5;\ z = \sin^2 x$
23	$y = \begin{cases} \ln|bzx| + za^{2.5}, & \text{if } a^3 < x \le b \\ ax^2 + bz^a + \sin^2 zx, & \text{if } x > b \\ \cos(ax + b) + \ln|zx|, & \text{if } x \le a^3 \end{cases}$	1. $a = 1.5;\ b = 6.4;\ z = \ln|bx^3 + 1.5|$ 2. $a = 1.9;\ b = 8.6;\ z = \ln|bx^3 + 3|$ 3. $a = 0.6;\ b = 2.4;\ z = \ln|bx^3 + 1.8|$
24	$y = \begin{cases} xe^x + (z + 7.7abx), & \text{if } x < a \\ tg(ax + z) + \cos^2 bx, & \text{if } a \le x \le b^2 \\ \ln(\sin^2(a + bx + zx^2)), & \text{if } x > b^2 \end{cases}$	1. $a = 8.7;\ b = 3.7;\ z = tg(bx)$ 2. $a = 9.3;\ b = 3.5;\ z = tg(abx)$ 3. $a = 2.1;\quad b = 5.7;\ z = tg(b^2 x)$

Continuation of the table 8.1 Variants of the individual tasks

№ of var	Formulas	Values of parameters
25	$y = \begin{cases} a + z\cos^2(bx)^3, & \text{if } \quad x < a \\ a + \sin^2 b^2 + \ln(zx), & \text{if } \quad a \le x \le b \\ \sqrt[3]{0.3b + \sqrt{\|(a - z^2 - \cos x)\|}}, & \text{if } \quad x > b \end{cases}$	1. $a=1.5;\; b=5.7;\; z=\ln\|tg(bx)\|$ 2. $a=3.7;\; b=8.4;\; z=\ln\|tg(bx)\|$ 3. $a=4.4;\; b=5.6;\; z=\ln\|tg(bx)\|$
26	$y = \begin{cases} \dfrac{(2z+1)^2}{3.71 - x^2}, & \text{if } \quad z > \text{-}0.5 \\ \sin^3 z - \sin\dfrac{z}{3\pi}, & \text{if } \; -0.5 \le z \le 10^{-3} \\ \dfrac{tg(z+x) - e^x}{3.5x} & \text{if } \quad z > 10^{-3} \end{cases}$	1. $\quad z = \arcsin x^3$ 2. $\quad z = \arccos^2 x$ 3. $\quad z = tgx$
27	$y = \begin{cases} a^2 x^3 + \sqrt{b^4 + 1.7}, & \text{if } \; \|x\| < 0.2 \\ arctg(2^x - \|p\|), & \text{if } \; \|x\| = 0.2 \\ \sqrt[3]{\ln\|a\| + 4.3} + x, & \text{if } \; \|x\| > 0.2 \end{cases}$	1. $a = 0.5;\; b = 1.5;\; p = -4$ 2. $a = -1;\; b = 0.5;\; p = -4$ 3. $a = -2;\; b = 0;\quad p = -4$
28	$y = \begin{cases} \sin(e^{a+b}) + x^2, & \text{if } \quad a+b > x \\ arctg(abc) + \sqrt[3]{x}, & \text{if } \quad a+b = x \\ \arcsin(\cos^2(\sqrt{\|x\|})), & \text{if } \quad a+b < x \end{cases}$	1. $a=7.2;\quad b=-1.3;\; c=2.5$ 2. $a=1.47;\quad b=3.81;\; c=2.8$ 3. $a=4.8;\quad b=10.6;\; c=2.7$
29	$y = \begin{cases} ctg(x^2 e^{3k}) + \ln\|r + x\|, & \text{if } \; x = rs \\ \sqrt[5]{x^2} + \sqrt{\|\arcsin k\|}, & \text{if } \; x > rs \\ arctg(kx + tg(rs)), & \text{if } \; x < rs \end{cases}$	1. $k=-0.3;\; r=0.85;\; s=3.5$ 2. $k=0.9;\quad r=3.3;\quad s=1.2$ 3. $k=-0.7;\; r=0.75;\; s=2.15$
30	$y = \begin{cases} a^3 + arctg(\sin^3 bx) + \cos^2 x^2, & \text{if } \quad x \le a \\ \sqrt{(a+bx) + 2} + \sin zx, & \text{if } \quad a < x < \ln b \\ arctg(a + bx + z), & \text{if } \quad x \ge \ln b \end{cases}$	1. $a=1.5;\; b=5.7;\; z=tn\|tg(bx)\|$ 2. $a=3.7;\; b=8.4;\; z=\ln\|tg(bx)\|$ 3. $a=4.4;\; b=5.6;\; z=\ln\|tg(bx)\|$

Problems for self-study

Assignment 1 (linear programs)

1. Create a project in C++ Builder to calculate the following functions according to the individual variants (table 9.1). Input necessary values from the screen.
2. Write the same program in console.
3. Draw the flowchart of the algorithm.

Table 9.1 Variants of the individual tasks

№ var	Individual function
1	$Y = (\pi x + arctg|x| - sign(x))^{\frac{1}{3}}$
2	$Y = \dfrac{bx}{|x|} + \dfrac{x^5}{\log_2 e^8}$
3	$Y = lg|a^7| + \dfrac{\pi}{e|a|^{1/3}}$
4	$Y = (arctgx^2 + \cos\sqrt{(\sin(x)^{2x})}$
5	$Y = e^x + \ln|x^{1/4}| + ctg(x)$
6	$Y = \sqrt{\left|\dfrac{ax+b}{cx-d}\right|}$
7	$Y = \dfrac{lg|x| - |\ln(x)|}{arctg(x) + 1}$
8	$Y = (x^{1/3} + sign(x^{1/5}))^{\sin(x)}$
9	$Y = \ln|x^{\cos(x)}| + tgax^{\sin(x)}$
10	$Y = \log_2(x + \cos\sqrt{|\sin(tg(x))|})$
11	$Y = (a + b - ctg(x))^{\frac{1}{|x|}}$
12	$Y = b + e^{\sqrt{|x + \cos(x) - tgx^3|}}$
13	$Y = \arcsin(\cos x + \sqrt{|tg(x)|})$
14	$\chi = 5arctgx - \dfrac{1}{4}\cos\dfrac{x + 3|x - y| + x^2}{|x + y^2|^3 + x^3}$
15	$\alpha = \ln(y^{-\sqrt{|x|}}) * (x - \dfrac{y}{2}) + \sin^2 arctgz + e^{x+y}$

Continuation of the table 9.1

№ var	Individual function
16	$Y = \dfrac{3x^2 + 15x^3 + 25x^8}{\left\lvert x^{10} \right\rvert + \ln(199)}$
17	$\beta = \sqrt{10(\sqrt{x} + x^{yz})(\sin^2 z - \lvert x + y \rvert)e^z}$
18	$Y = \sqrt{tg^2(x) + \lg \lvert ctg(x) \rvert}$
19	$\varphi = \dfrac{e^{\lvert x - y \rvert} \lvert x - y \rvert^{x+y}}{arctgx + tgz} + \sqrt{x^6 + \ln^2 y}$
20	$\phi = \left\lvert x^{\frac{y}{x}} - \sqrt{\dfrac{y}{x}} \right\rvert + (y - x)\dfrac{\cos y - e^{\frac{z}{(y-x)}}}{1 + (y - x)^2}$
21	$\delta = y^x + \sqrt{\lvert x \rvert + e^y} - \dfrac{z^3 \sin^2 y}{y + \dfrac{z^3}{y - z^3}}$
22	$\varepsilon = \left\lvert \cos x - e^y \right\rvert^{1 + 2\ln^2 y}(1 + z + \dfrac{z^2}{2} + \dfrac{z^3}{3})$
23	$\lambda = \dfrac{1 + \sin^2(x + y)}{\left\lvert e^x - \dfrac{2y}{1 + x^2 y^3} \right\rvert} x^{\lvert y \rvert} + \cos^2(arctg\dfrac{1}{z})$
24	$\eta = \dfrac{\sqrt{8 + \lvert x + y \rvert^2 + z}}{x^2 + y^2 + z^2} - e^{\lvert x - y \rvert}(tg^2 z + \sqrt[5]{\lvert z \rvert})$
25	$\sigma = \dfrac{2\cos(x - \dfrac{\pi}{6})}{e^{0.5} + \sin^2 y}(1 + \dfrac{z^2}{3 - z^5/5})$
26	$\chi = y + \dfrac{e^{x-y}}{y + \dfrac{x^2}{y + \dfrac{x^3}{y}}}(1 + tg^2 \dfrac{z}{3})^{\sqrt{\lvert y \rvert + 7}}$
27	$\theta = \lg(\sqrt{e^{x-y} + x^{\lvert y \rvert}} + z)(x - \dfrac{x^3}{3} - \dfrac{x^7}{7})$

Continuation of the table 9.1

№ var	Individual function
28	$\varpi = 6 + \dfrac{e^{x-\sin y}}{y + \dfrac{tg(x^2)}{(y + \dfrac{x^7}{z})}}(1 + ctg^7 \dfrac{z}{100})^{\sqrt{|y|+3}}$
29	$\tau = \dfrac{2x(1+x^2)^2}{x + \sqrt[3]{\|1 + x^5\|}}\left(\dfrac{\sqrt{x}}{2y + 10}\right)$
30	$\xi = \dfrac{x + \dfrac{y}{5 + \sqrt{x}}}{|y - x| + \sqrt[3]{x}}e^{z+1} + \sin^3 z$

Assignment 2 (programs with branching)
1. Create a project in C++ Builder to calculate the following functions (use if conditional statement) according to the individual variants (table 9.2). Input all necessary values from the screen.
2. Draw the flowchart of the algorithm.

Table 9.2 Variants of the individual tasks

№ var	Individual function
1	$S = \begin{cases} \dfrac{\sin(n_1 - 2n_2)}{1 + 2n_1}, p < 2n_2 \leq 1 \\ 5(n_1 - 3\cos(n_2)), n_1 - 2n_2 > 1 \end{cases}$
2	$y = \sin\cos\begin{cases} b^m - ax\sin x, a^m > bx\cos x \\ \log\left|tg^m(\cos(ab) - x^b)^m\right|, a \geq b \end{cases}$
3	$S = \begin{cases} \dfrac{n_1 - 2n_2}{1 + 2n_1}, p < n_1 - 2n_2 \leq 1 \\ 2(n_1 - 2n_2), n_1 - 2n_2 > 1 \end{cases}$
4	$y = \sin\cos\begin{cases} a^m - bxtgx, a^m > bxtgx \\ \log\left|tg^m(a - x^b)^m\right|, a \geq b \end{cases}$
5	$S = \begin{cases} \dfrac{n_1 - 2n_2}{1 + 2n_1}, p < n_1 - 2n_2 \leq 1 \\ 2(n_1 - 2n_2), n_1 - 2n_2 > 1 \end{cases}$

Continuation of the table 9.2

№ var	Individual function
6	$y = tg \begin{cases} \dfrac{1}{m+1}\cos(10^{-3}\ln\left|\sin^{am}bx\right|, tg^{a}bx > \sin bx \\ \cos^{m}\ln(a+bx), tg^{b}ax \geq \cos ax \end{cases}$
7	$L = \begin{cases} \dfrac{3U_n + V_n}{Un^2 + Vn^2}, \left|U_n\right| > \left|V_n\right| \\ V_n - U_n, n < \left|U_n\right| \leq \left|V_n\right| \end{cases}$
8	$K = \begin{cases} \sqrt{\left|Se^2 - ne^{-2}\right|}, \left|n\right| < s < 2\left|n\right| \\ \sqrt{\left|Sn\right|}, s \geq 2\left|n\right| \end{cases}$
9	$y = \lg \begin{cases} tg\left|a - \dfrac{b}{x}\right|, a^x \geq e^x \\ tg^{\frac{1}{m}}(e^x - a^x)^{\frac{1}{2}}, a^{bn\leq} < \cos^m x \end{cases}$
10	$y = 3tg \begin{cases} \sin^2 m^a \lg x^{ab}, \cos^{ab} > 0 \\ tg(b - 10^4 x)\sin^{\frac{3}{m}} x, \cos^{ab} < 0 \end{cases}$
11	$y = tg^{\frac{4}{m}} \begin{cases} \cos^2\left|\ln\sin(a + bx^m)\right|, 0 < a + bx^m < \pi \\ tg^m\left|\cos^{\sin ax}\sin(a + bx\right| \end{cases}$
12	$U = \begin{cases} \ln(\left|P\right| + \left|n\right|), 0 < P < n + 1 \\ \lg(\left|P - n\right|), P \geq n + 1 \end{cases}$
13	$y = \cos \begin{cases} \sin^2 arctg(\cos x)^{\frac{1}{2}}, -\dfrac{\pi}{2} \leq x \leq \dfrac{\pi}{2} \\ \lg m arctg^2\left|x\right| \end{cases}$
14	$M_x = \begin{cases} 3m_1^4 + 4m_1^3, \left|m_1\right| + \left|m_j\right| \geq 1 \\ m_1^2 - m_j^2, \left|m_1\right| + \left|m_j\right| < 1 \end{cases}$
15	$y = \ln\left|\cos^3\right| \begin{cases} -x, x < 0 \\ mx^{\frac{1}{2}}, x > 0, x > 0 \end{cases}$
16	$N = \begin{cases} \sqrt{\left|xe + te^{-2}\right|}, 3t < x < 10t \\ \sqrt{\left|x + t\right|}, x \geq 10t \end{cases}$
17	$y = \sin m \begin{cases} arctg\cos^2(x-1)^{\frac{1}{2}}, a < x < b \\ \sin x, x \geq b \end{cases}$

Continuation of the table 9.2

№ var	Individual function
18	$L = \begin{cases} 2K^3 + 3P^2, K > \lvert P \rvert \\ \lvert K - P \rvert, \pi < K \leq \lvert P \rvert \end{cases}$
19	$y = \cos m \begin{cases} \sin^2 x, x \geq 0 \\ \cos^3, x = 0 \\ \sin(\ln(-x)), x < 0 \end{cases}$
20	$K = \begin{cases} \ln(\lvert f \rvert + \lvert q \rvert), \lvert fq \rvert > 10 \\ e^{f+q}, \lvert fq \rvert < 10 \end{cases}$
21	$y = \begin{cases} \cos^2 x, x > bm \\ \sin x, a \leq x \leq b \\ \cos^3 x, x < a \end{cases}$
22	$M = \begin{cases} e^{\lvert \alpha \rvert - \lvert \beta \rvert}, \alpha\beta > 0.5 \\ \lvert \alpha + \beta \rvert, 0.1 < \alpha\beta \leq 0.5 \end{cases}$
23	$y = \begin{cases} \sin m \cos^2 x, x \geq 0 \\ \sin m \sin^2 x, x < 0 \end{cases}$
24	$P = \begin{cases} \sin(5k + 3m\ln\lvert k \rvert). -1 < k \leq m \\ \cos(5k + 3m\ln\lvert k \rvert), k \geq m \end{cases}$
25	$S = \cos \begin{cases} b^m - bxtgax, a^m < bx \\ \ln\lvert \sin^m \left(\cos(ax) - x^a\right)^m \rvert, a \geq b \end{cases}$
26	$Y = \begin{cases} 7x^5 + 3.2w^{-2}, x > \lvert w \rvert \\ \lvert w^3 - x \rvert, \pi < x \leq \lvert w \rvert \end{cases}$
27	$W = \begin{cases} \sqrt{3\ln\lvert ab \rvert}, a > b \\ \sqrt[4]{a^5 + a^{-2}b^4}, a \leq 2\lvert b \rvert \end{cases}$
28	$T = \begin{cases} \dfrac{3x^4 + xy^3}{xn^2 + yn^{-2}}, \lvert x \rvert \geq \lvert y \rvert \\ \sqrt[3]{\lg\lvert y - x \rvert}, n < \lvert x \rvert < \lvert y \rvert \end{cases}$
29	$D = \begin{cases} \dfrac{a^3 - 2b^2}{\sqrt{1 + 2a}}, a - 2b \leq 1 \\ 2tg(a^4 - 2b), a - 2b > 1 \end{cases}$

Test

1. What is the only function all console C programs must contain?

A) start()
B) system()
C) main()
D) program()

2. What punctuation is used to signal the beginning and end of code blocks?

A) { }
B) -> and <-
C) BEGIN and END
D) (and)

3. What punctuation ends most lines of C code?

A) .
B) ;
C) :
D) '

4. Which of the following is a correct comment?

A) */ Comments */
B) ** Comment **
C) /* Comment */
D) { Comment }

5. Which of the following is not a correct variable type?

A) float
B) real
C) int
D) double

6. Which of the following is the correct operator to compare two variables?

A) :=
B) =
C) equal
D) ==

7. Which of the following is true?

A) 1
B) 66
C) .1
D) -1
E) All of the above

8. Which of the following is the boolean operator for logical AND?

A) &
B) &&
C) |
D) |&

9. Evaluate !(1 && !(0 || 1)).

A) True
B) False
C) Unevaluatable

10. Which of the following shows the correct syntax for an **if** statement?

A) if *expression*
B) if {*expression*
C) if (*expression*)
D) *expression* if