

**MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION OF HIGHER EDUCATION
NORTH CAUCASIAN FEDERAL UNIVERSITY**

Methodological guidelines
on completing practical work on the discipline
Innovative Training Practice Course (Mathematical Modeling) /
Инновационный курс практического обучения (математическое
моделирование)
Direction of training
02.04.01 Mathematics and Computer Science
Training profile
Training Program for Electronic Information

Stavropol, 2026

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION OF HIGHER EDUCATION
NORTH CAUCASIAN FEDERAL UNIVERSITY

Guidelines for the implementation of practical work
by discipline

Innovative Training Practice Course (Mathematical Modeling) /
Инновационный курс практического обучения (математическое
моделирование)

for students in the field of study
02.04.01 Mathematics and Computer Science

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Introduction

The goal of mastering the discipline " Innovative Training Practice Course (Mathematical Modeling) / Инновационный курс практического обучения (математическое моделирование) " is for each student to acquire a set of professional and general cultural competencies in the field of hardware development of modern high-performance logic circuits.

The main objectives of studying the discipline are:

1. Overview of basic logic circuits.
2. Study of the Xilinx ISE 14.7 computer design environment.
3. Learning the basics of the VHDL logic design language.
4. VHDL implementation of logic circuits of conventional (binary) and modular arithmetic.
5. VHDL implementation of high-performance digital signal processing logic circuits.

Reporting forms: credit - 7th semester.

Course Contents: Classification of Modern Logic Circuits, Overview of Basic Logic Circuits in Microelectronics, Not, Buffer, And, Or, Exclusive Or, And-Not, Or-Not Gates, Multiplexers, Demultiplexers, Encoders, Decoders, Triggers, Registers, Counters, Synthesis of Universal Combinational Circuits Based on Multiplexers, Synthesis of Universal Combinational Circuits Based on Encoders and Decoders, Synchronous and Asynchronous Circuits, Mealy State Machine, Moore State Machine, Xilinx ISE 14.7 Integrated Development Environment for Very Large-Scale Integrated Circuits, Circuit Simulation, Circuit Implementation, Circuit Flashing in FPGA, Specifics of the Hardware Description Language, VHDL Project Structure, VHDL Data Types, Sequential and Parallel Processes in VHDL, Implementation of Branching Constructs in VHDL, Implementation of Cyclic Constructs in VHDL, Parameterized modules in VHDL, Signal attributes in VHDL, Modular design in VHDL, Addition and subtraction of binary numbers, Multiplication of binary numbers, Division of binary numbers, Comparison of binary numbers, Encoding of negative numbers in the binary number system, Representation Of rational numbers in the binary number system, Modular arithmetic, Digital filters.

Implemented competencies:

PC-3. Ability to collect, process and interpret experimental data necessary for project activities in the field of information technology

PC-5. Capable of developing software and information support for computer systems, services, computing complexes, and databases.

Recommended software:

Xilinx ISE Webpackedition 14.7, a very large-scale integrated circuit (VLSI) design environment

Text editor for report design (LibreOffice 4. x , 5. x or OpenOffice)

Operating system: Windows (version not lower than XP), Linux (Mint not lower than 17.2)

Recommended equipment: a computer lab (or laboratory, or classroom) with a number of working computers equal to the number of students in the class, plus a teacher workstation, and with sufficient performance to cover the course. All computers in the lab or classroom must be equipped with software and internet access for studying online resources for the course (with access speeds sufficient for comfortable use).

Practical work No. 1

Topic: " Classification of modern electronic circuits "

The purpose of the work: “ to consolidate knowledge on the theoretical foundations of the classification of modern electronic circuits .”

Competencies being developed (part of the competencies is being developed) :

PC-1: Ability to demonstrate general scientific basic knowledge of mathematical and natural sciences, fundamental computer science and information technology; ability to apply modern programming languages and parallel data processing methods, operating systems, electronic libraries and software packages, network technologies in professional activities

Progress of work

1. Organizational moment (registration in the laboratory, review of safety rules for working on a computer, preparation of the workplace, launch of the Xilinx ISE 14.7 design environment)
2. Familiarization with the basic, additional, and methodological literature, as well as Internet sources, necessary for completing laboratory work.
3. Prepare a report on the laboratory work.
4. Project protection.
5. Completion of work (disabling the design environment, tidying up the workspace)

Theoretical part

See the list of recommended reading.

Equipment and materials: see Appendix 1.

Safety precautions: see Appendix 3.

Assignments for laboratory work

Abstract review of information (Internet) sources for the assignment.

1. Classification of modern electronic circuits
2. Overview of Basic Microelectronics Circuits
3. Gates "not", "buffer", "and", "or", "exclusive or", "and-not", "or-not"
4. Multiplexers
5. Demultiplexers
6. Encryptors
7. Decoders
8. Triggers
9. Registers
10. Counters
11. Synthesis of universal combinational circuits based on multiplexers
12. Synthesis of universal combinational circuits based on encoders and decoders

Please provide information sources and their contents as specified in the assignment. Text, hyperlinks, tables, figures, and any other information that facilitates viewing and protection of the presentation/report are permitted. Only open, publicly accessible sources of information that do not require copyright transfer or any other royalties are permitted.

Security questions

1. Classification of modern electronic circuits
2. Overview of Basic Microelectronics Circuits
3. Gates "not", "buffer", "and", "or", "exclusive or", "and-not", "or-not"
4. Multiplexers
5. Demultiplexers
6. Encryptors
7. Decoders

8. Triggers
9. Registers
10. Counters
11. Synthesis of universal combinational circuits based on multiplexers
12. Synthesis of universal combinational circuits based on encoders and decoders

A list of recommended literature on this topic

Main:

1. GOST R 50754-95. VHDL Digital Systems Hardware Description Language. Language Description. Moscow: Gosstandart of Russia, 1995.
2. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
3. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

Additional:

1. Xilinx FPGAs in the WebPACKISE environment / compiled by G.V. Malinin, S.V. Abramov, A.V. Serebryannikov. Cheboksary: Publishing house of Chuvashia University, 2013.

Methodical:

1. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
2. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

Internet resources

1. Electronic library "Wikipedia" [electronic resource] / <http://www.wikipedia.org>
2. Official website of Xilinx [electronic resource] / <http://www.xilinx.com>

Practical work #2

Subject: " Xilinx ISE 14.7 Integrated Development Environment for Very Large-Scale Integrated Circuits "

The purpose of the work: “ to consolidate knowledge of the theoretical foundations of working in the Xilinx ISE 14.7 ultra-large integrated circuit development environment .”

Competencies being developed (part of the competencies is being developed) :

PC-1: Ability to demonstrate general scientific basic knowledge of mathematical and natural sciences, fundamental computer science and information technology; ability to apply modern programming languages and parallel data processing methods, operating systems, electronic libraries and software packages, network technologies in professional activities

Progress of work

1. Organizational moment (registration in the laboratory, review of safety rules for working on a computer, preparation of the workplace, launch of the Xilinx ISE 14.7 design environment)
2. Familiarization with the basic, additional, and methodological literature, as well as Internet sources, necessary for completing laboratory work.
3. Selecting an assignment option, registering the selected option with the teacher.
4. Working on the project.
 - 4.1. Develop and implement in the Xilinx ISE 14.7 schematic editor a schematic diagram of a device that calculates the values of a logical function from four variables x_0, x_1, x_2, x_3 , specified by a truth table, where d_n corresponds to the corresponding set of bits x_3, x_2, x_1, x_0 of a decimal number, for example, d_5 corresponds to $x_0=1, x_1=0, x_2=1, x_3=0$ (in accordance with the variant). Synthesize the circuit.
 - 4.2. Develop and implement a device model in VHDL using the Xilinx ISE 14.7 design environment that calculates the values of a logical function specified by a truth table (according to the variant). Synthesize the circuit.
 - 4.3. Create a test simulator of the devices created in tasks 4.1 and 4.2 in the Xilinx ISE 14.7 design environment. Obtain timing diagrams of the circuit simulation.
5. Prepare a report on the laboratory work.
6. Project protection.
7. Completion of work (disabling the design environment, tidying up the workspace)

Theoretical part

See the list of recommended reading.

Equipment and materials: see Appendix 1.

Safety precautions: see Appendix 3.

Assignments for laboratory work

1. Develop and implement in the Xilinx ISE 14.7 schematic editor a schematic diagram of a device that calculates the values of a logical function from four variables x_0, x_1, x_2, x_3 , specified by a truth table, where d_n corresponds to the corresponding set of bits x_3, x_2, x_1, x_0 of a decimal number, for example, d_5 corresponds to $x_0=1, x_1=0, x_2=1, x_3=0$ (in accordance with the variant). Synthesize the circuit.
2. Develop and implement a device model in VHDL using the Xilinx ISE 14.7 design environment that calculates the values of a logical function specified by a truth table (according to the variant). Synthesize the circuit.
3. Create a test simulator of the devices created in tasks 1 and 2 in the Xilinx ISE 14.7 design environment. Obtain timing diagrams of the circuit simulation.

Var.	d0	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15
1	1	0	0	1	0	0	1	1	1	1	0	1	0	1	1	1

2	0	1	1	0	1	1	1	1	1	1	1	1	0	1	1	0
3	0	1	0	1	1	1	1	1	1	1	0	0	1	0	0	1
4	1	1	0	0	1	1	1	1	0	0	1	1	1	0	1	0
5	0	0	1	1	0	0	0	1	1	0	1	0	0	1	1	1
6	1	0	0	0	1	0	0	1	0	1	0	0	1	0	1	0
7	0	1	1	0	0	1	1	0	1	0	1	1	0	1	1	0
8	0	1	0	0	1	1	1	1	0	0	0	1	0	1	1	0
9	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
10	0	0	1	1	0	1	1	0	1	1	0	0	1	0	0	0
11	1	1	1	0	1	1	0	0	1	1	1	0	1	0	1	0
12	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	1
13	0	1	0	1	1	0	0	0	1	1	0	0	0	0	0	1
14	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0
15	0	0	0	1	1	0	1	0	1	1	0	1	1	0	0	1
16	0	0	1	0	1	1	0	1	0	0	0	0	1	0	0	1
17	0	1	1	0	1	0	0	1	1	0	1	1	0	0	0	0
18	0	0	1	0	0	0	0	0	1	1	0	0	1	1	0	0
19	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0
20	1	1	0	0	0	1	1	0	0	1	0	1	1	0	1	0
21	1	1	0	0	1	0	1	0	0	0	0	1	1	0	0	1
22	1	1	0	1	1	1	0	1	1	1	1	0	1	0	1	1
23	0	0	1	1	1	1	1	1	1	0	0	0	0	0	1	0
24	1	0	0	0	1	0	0	1	1	0	0	1	1	0	1	0
25	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0
26	1	0	1	0	1	1	0	1	1	1	0	1	0	1	1	1
27	0	0	0	0	1	1	0	0	1	0	1	0	1	1	1	1
28	0	0	0	1	0	0	1	0	1	1	1	1	0	1	1	1
29	1	1	0	1	1	0	0	1	0	0	1	1	0	0	0	1
30	1	1	1	0	0	1	1	0	0	0	0	0	1	1	0	1

Security questions

Classification of modern electronic circuits

Overview of Basic Microelectronics Circuits

Gates "not", "buffer", "and", "or", "exclusive or", "and-not", "or-not"

Multiplexers

Demultiplexers

Encryptors

Decoders

Triggers

Registers
Counters
Synthesis of universal combinational circuits based on multiplexers
Synthesis of universal combinational circuits based on encoders and decoders
Xilinx ISE 14.7 Ultra-Large-Scale Integrated Circuits (VLSI) Development Environment
Circuit simulation
Implementation of the scheme
Flashing the circuit into FPGA
Specifics of the hardware description language
VHDL Project Structure

A list of recommended literature on this topic

Main:

4. GOST R 50754-95. VHDL Digital Systems Hardware Description Language. Language Description. Moscow: Gosstandart of Russia, 1995.
5. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
6. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

Additional:

2. Xilinx FPGAs in the WebPACKISE environment / compiled by G.V. Malinin, S.V. Abramov, A.V. Serebryannikov. Cheboksary: Publishing house of Chuvashia University, 2013.

Methodical:

3. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
4. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

Internet resources

3. Electronic library "Wikipedia" [electronic resource] / <http://www.wikipedia.org>
4. Official website of Xilinx [electronic resource] / <http://www.xilinx.com>

Practical work #3

Topic: " Fundamentals of the VHDL hardware design language "

The purpose of the work: “ to consolidate knowledge of the theoretical foundations of the VHDL hardware design language .”

Competencies being developed (part of the competencies is being developed) :

PC-1: Ability to demonstrate general scientific basic knowledge of mathematical and natural sciences, fundamental computer science and information technology; ability to apply modern programming languages and parallel data processing methods, operating systems, electronic libraries and software packages, network technologies in professional activities

Progress of work

1. Organizational moment (registration in the laboratory, review of safety rules for working on a computer, preparation of the workplace, launch of the Xilinx ISE 14.7 design environment)
2. Familiarization with the basic, additional, and methodological literature, as well as Internet sources, necessary for completing laboratory work.
3. Prepare a report on the laboratory work.
4. Project protection.
5. Completion of work (disabling the design environment, tidying up the workspace)

Theoretical part

See the list of recommended reading.

Equipment and materials: see Appendix 1.

Safety precautions: see Appendix 3.

Assignments for laboratory work

Abstract review of information (Internet) sources for the assignment.

1. Specifics of the hardware description language
2. VHDL Project Structure
3. VHDL data types
4. Sequential and parallel processes in VHDL
5. Implementation of branching constructs in VHDL
6. Implementation of cyclic constructs in VHDL
7. Parameterized modules in VHDL
8. Signal attributes in VHDL
9. Modular design in VHDL

Please provide information sources and their contents as specified in the assignment. Text, hyperlinks, tables, figures, and any other information that facilitates viewing and protection of the presentation/report are permitted. Only open, publicly accessible sources of information that do not require copyright transfer or any other royalties are permitted.

Security questions

1. Specifics of the hardware description language
2. VHDL Project Structure
3. VHDL data types
4. Sequential and parallel processes in VHDL
5. Implementation of branching constructs in VHDL
6. Implementation of cyclic constructs in VHDL
7. Parameterized modules in VHDL
8. Signal attributes in VHDL
9. Modular design in VHDL

A list of recommended literature on this topic

Main:

1. GOST R 50754-95. VHDL Digital Systems Hardware Description Language. Language Description. Moscow: Gosstandart of Russia, 1995.
2. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
3. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.
4. Additional:
5. Xilinx FPGAs in the WebPACKISE environment / compiled by G.V. Malinin, S.V. Abramov, A.V. Serebryannikov. Cheboksary: Publishing house of Chuvashia University, 2013.
6. Methodical:
7. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
8. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.
9. Internet resources
10. Electronic library "Wikipedia" [electronic resource] / <http://www.wikipedia.org>
11. Official website of Xilinx [electronic resource] / <http://www.xilinx.com>

Practical work #4

Topic: “ VHDL implementation of binary arithmetic circuits ”

The purpose of the work: “ to consolidate knowledge on the theoretical foundations of VHDL implementation of binary arithmetic circuits .”

Competencies being developed (part of the competencies is being developed) :

PC-1: Ability to demonstrate general scientific basic knowledge of mathematical and natural sciences, fundamental computer science and information technology; ability to apply modern programming languages and parallel data processing methods, operating systems, electronic libraries and software packages, network technologies in professional activities

Progress of work

1. Organizational moment (registration in the laboratory, review of safety rules for working on a computer, preparation of the workplace, launch of the Xilinx ISE 14.7 design environment)
2. Familiarization with the basic, additional, and methodological literature, as well as Internet sources, necessary for completing laboratory work.
3. Selecting an assignment option, registering the selected option with the teacher.
4. Working on the project.
 - 4.1. Develop and implement a model of a device that calculates the value of an arithmetic expression (according to the variant) in VHDL using the Xilinx ISE 14.7 design environment. Synthesize the circuit.

Warning! Using ready-made IEEE binary arithmetic library modules is prohibited (i.e., you must create your own modules to perform arithmetic operations on binary numbers). The input and output signal width is 32 bits.
 - 4.2. Create a test simulator of the device created in task 4.1 in the Xilinx ISE 14.7 design environment. Obtain timing diagrams of the circuit simulation.
5. Prepare a report on the laboratory work.
6. Project protection.
7. Completion of work (disabling the design environment, tidying up the workspace)

Theoretical part

See the list of recommended reading.

Equipment and materials: see Appendix 1.

Safety precautions: see Appendix 3.

Assignments for laboratory work

1. Develop and implement a model of a device that calculates the value of an arithmetic expression (according to the variant) in VHDL using the Xilinx ISE 14.7 design environment. Synthesize the circuit.

Warning! Using ready-made IEEE binary arithmetic library modules is prohibited (i.e., you must create your own modules to perform arithmetic operations on binary numbers). The input and output signal width is 32 bits.

2. Create a test simulator of the device created in task 1 in the Xilinx ISE 14.7 design environment. Obtain timing diagrams of the circuit simulation.

Var.	Formula	Var.	Formula
1		16	
2		17	
3		18	
4		19	

5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11		26	
12		27	
13		28	
14		29	
15		30	

Security questions

Xilinx ISE 14.7 Ultra-Large-Scale Integrated Circuits (VLSI) Development Environment

Circuit simulation

Implementation of the scheme

Flashing the circuit into FPGA

Specifics of the hardware description language

VHDL Project Structure

VHDL data types

Sequential and parallel processes in VHDL

Implementation of branching constructs in VHDL

Implementation of cyclic constructs in VHDL

Parameterized modules in VHDL

Signal attributes in VHDL

Modular design in VHDL

Addition and subtraction of binary numbers

Multiplication of binary numbers

Division of binary numbers

Comparison of binary numbers

Coding negative numbers in the binary number system

Representation of rational numbers in the binary number system

A list of recommended literature on this topic

Main:

1. GOST R 50754-95. VHDL Digital Systems Hardware Description Language. Language Description. Moscow: Gosstandart of Russia, 1995.
2. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
3. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.
4. B. Parhami, Computer Arithmetic: Algorithms and Hardware Designs, 2nd edition, Oxford University Press, New York, 2010.

Additional:

1. Xilinx FPGAs in the WebPACKISE environment / compiled by G.V. Malinin, S.V. Abramov, A.V. Serebryannikov. Cheboksary: Publishing house of Chuvashia University, 2013.
2. Tanenbaum E. Computer Architecture. 5th ed. - St. Petersburg: Piter, 2007.

Methodical:

1. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
2. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.
3. Internet resources
4. Electronic library "Wikipedia" [electronic resource] / <http://www.wikipedia.org>
5. Official website of Xilinx [electronic resource] / <http://www.xilinx.com>

Practical work #5

Topic: " VHDL implementation of modular arithmetic circuits ".

The purpose of the work: “ to consolidate knowledge on the theoretical foundations of VHDL implementation of modular arithmetic circuits .”

Competencies being developed (part of the competencies is being developed) :

PC-1: Ability to demonstrate general scientific basic knowledge of mathematical and natural sciences, fundamental computer science and information technology; ability to apply modern programming languages and parallel data processing methods, operating systems, electronic libraries and software packages, network technologies in professional activities

Progress of work

1. Organizational moment (registration in the laboratory, review of safety rules for working on a computer, preparation of the workplace, launch of the Xilinx ISE 14.7 design environment)
2. Familiarization with the basic, additional, and methodological literature, as well as Internet sources, necessary for completing laboratory work.
3. Selecting an assignment option, registering the selected option with the teacher.
4. Working on the project.
 - 4.1. Develop and implement a device model in VHDL in the Xilinx ISE 14.7 design environment:
 - a) converting input data from the binary number system to the residual class system
 - b) calculating the value of an arithmetic expression in the system of residual classes (in accordance with the option)
 - c) converting the obtained result from the system of residual classes into the binary number system.
 - d) Synthesize the circuit.Important! Use of ready-made IEEE binary arithmetic library modules is permitted. Input and output signal width is 32 bits.
 - 4.2. Create a test simulator of the device created in task 4.1 in the Xilinx ISE 14.7 design environment. Obtain timing diagrams of the circuit simulation.
5. Prepare a report on the laboratory work.
6. Project protection.
7. Completion of work (disabling the design environment, tidying up the workspace)

Theoretical part

See the list of recommended reading.

Equipment and materials: see Appendix 1.

Safety precautions: see Appendix 3.

Assignments for laboratory work

1. Develop and implement a device model in VHDL in the Xilinx ISE 14.7 design environment:
 - a) converting input data from the binary number system to the residual class system
 - b) calculating the value of an arithmetic expression in the system of residual classes (in accordance with the option)
 - c) converting the obtained result from the system of residual classes into the binary number system.
 - d) Synthesize the circuit.Important! Use of ready-made IEEE binary arithmetic library modules is permitted. Input and output signal width is 32 bits.
2. Create a test simulator of the device created in task 1 in the Xilinx ISE 14.7 design environment. Obtain timing diagrams of the circuit simulation.

Var.	Formula	p1	p2	p3	p4	p5
1		149	163	149	211	149
2		223	227	239	211	251
3		239	227	239	137	157
4		137	157	193	241	233
5		227	229	251	199	251
6		193	199	197	167	149
7		227	151	241	227	223
8		197	131	181	179	251
9		149	199	251	157	157
10		193	157	193	227	199
11		211	229	241	167	233
12		149	193	179	193	151
13		197	151	173	163	137
14		131	137	151	151	193
15		229	251	239	211	151
16		191	139	227	137	157
17		229	167	193	179	241
18		233	251	199	233	139
19		239	223	239	211	239
20		191	149	197	163	191
21		157	239	199	193	137
22		227	179	193	241	137
23		181	137	191	157	151
24		157	163	227	239	137
25		251	211	167	229	179
26		191	179	157	191	149
27		167	199	197	239	251
28		211	199	233	181	251
29		251	197	211	167	251
30		211	151	229	197	227

Security questions

Xilinx ISE 14.7 Ultra-Large-Scale Integrated Circuits (VLSI) Development Environment
Circuit simulation
Implementation of the scheme
Flashing the circuit into FPGA
Specifics of the hardware description language
VHDL Project Structure
VHDL data types
Sequential and parallel processes in VHDL
Implementation of branching constructs in VHDL
Implementation of cyclic constructs in VHDL
Parameterized modules in VHDL
Signal attributes in VHDL
Modular design in VHDL
Addition and subtraction of binary numbers
Multiplication of binary numbers
Division of binary numbers
Comparison of binary numbers
Coding negative numbers in the binary number system
Representation of rational numbers in the binary number system
Modular arithmetic

A list of recommended literature on this topic

Main:

1. GOST R 50754-95. VHDL Digital Systems Hardware Description Language. Language Description. Moscow: Gosstandart of Russia, 1995.
2. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
3. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.
4. B. Parhami, Computer Arithmetic: Algorithms and Hardware Designs, 2nd edition, Oxford University Press, New York, 2010.

Additional:

1. Akushsky I.Ya., Yuditsky D.I. Machine arithmetic in residual classes. – M.: Soviet Radio, 1968.
2. Xilinx FPGAs in the WebPACKISE environment / compiled by G.V. Malinin, S.V. Abramov, A.V. Serebryannikov. Cheboksary: Publishing house of Chuvashia University, 2013.
3. Tanenbaum E. Computer Architecture. 5th ed. - St. Petersburg: Piter, 2007.
4. Amos Omondi, Benjamin Premkumar. Residue Number System. Theory and implementation. - London: Imperial College Press, 2007.

Methodical:

1. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
2. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

Literature

Main literature

GOST R 50754-95. VHDL Digital Systems Hardware Description Language. Language Description. Moscow: Gosstandart of Russia, 1995.

Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.

Innovative course of practical training (mathematical modeling): study guide – laboratory workshop / compiled by: Chervyakov N.I., Galushkin A.I., Babenko M.G., Kuchukov V.A. – Stavropol: SKFU Publishing House, 2016

Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

B. Parhami, Computer Arithmetic: Algorithms and Hardware Designs, 2nd edition, Oxford University Press, New York, 2010.

Further reading

Akushsky I.Ya., Yuditsky D.I. Machine arithmetic in residual classes. – M.: Soviet Radio, 1968.

Modular parallel computing structures of neuroprocessor systems / N. I. Chervyakov, P. A. Sakhnyuk, A. V. Shaposhnikov, S. A. Ryadnov; Ed. N. I. Chervyakov. - M.: FIZMATLIT, 2003.

Xilinx FPGAs in the WebPACKISE environment / compiled by G.V. Malinin, S.V. Abramov, A.V. Serebryannikov. Cheboksary: Publishing house of Chuvashia University, 2013.

Tanenbaum E. Computer Architecture. 5th ed. - St. Petersburg: Piter, 2007.

Amos Omondi, Benjamin Premkumar. Residue Number System. Theory and implementation. - London: Imperial College Press, 2007.

Methodological literature

Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.

Innovative course of practical training (mathematical modeling): study guide – laboratory workshop / compiled by: Chervyakov N.I., Galushkin A.I., Babenko M.G., Kuchukov V.A. – Stavropol: SKFU Publishing House, 2016

Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

Internet resources

Electronic library "Wikipedia" [electronic resource] / <http://www.wikipedia.org>

Official website of Xilinx [electronic resource] / <http://www.xilinx.com>

Practical work #6

Topic: " Development of digital information processing devices ."

The purpose of the work: “ to consolidate knowledge on the theoretical foundations of VHDL implementation of digital information processing circuits .”

Competencies being developed (part of the competencies is being developed) :

PC-7: ability to develop and apply algorithmic and software solutions in the field of system and application software;

Progress of work

1. Organizational moment (registration in the laboratory, review of safety rules for working on a computer, preparation of the workplace, launch of the Xilinx ISE 14.7 design environment)
2. Familiarization with the basic, additional, and methodological literature, as well as Internet sources, necessary for completing laboratory work.
3. Selecting a laboratory assignment option, registering the selected option with the instructor.
4. Working on the project.
- 4.1. Develop and implement a finite-state machine model in VHDL using the Xilinx ISE 14.7 design environment. This machine performs digital processing of a one-dimensional input signal using specified filter coefficients (as per the design option). Specify the filter termination signal sequence yourself. Synthesize the circuit. The input and output signal width is 32 bits.
- 4.2. Create a test simulator of the device created in task 4.1 in the Xilinx ISE 14.7 design environment. Obtain timing diagrams of the circuit simulation.
5. Prepare a report on the laboratory work.
6. Project protection.
7. Completion of work (disabling the design environment, tidying up the workspace)

Theoretical part

See the list of recommended reading.

Equipment and materials: see Appendix 1.

Safety precautions: see Appendix 3.

Assignments for practical work

Var.	I know.	k1	k2	k3	k4	k5	k6	k7	k8
1	3	6	0	-14	-14	-15	14	-10	-6
2	13	7	1	14	-11	8	-4	7	-9
3	14	8	-11	-2	7	-3	-6	-13	2
4	5	-5	-1	7	4	-14	-3	7	3
5	6	-4	4	4	-13	11	6	-4	10
6	8	6	7	5	-15	5	13	14	-1
7	2	-1	13	6	15	10	7	3	15
8	1	5	-13	7	8	14	-6	-15	5
9	14	-5	14	14	6	-5	-2	-3	-8
10	13	-8	0	7	-5	8	13	6	6
11	4	8	15	5	8	-6	12	7	15
12	5	-8	-3	-6	12	-8	-7	-12	-2

13	15	-14	15	-9	-12	-15	-10	-14	7
14	11	5	-2	9	0	-15	-10	1	1
15	6	10	3	7	14	10	2	0	-8
16	15	-9	-5	13	8	2	6	11	-9
17	9	-15	5	4	9	2	7	-12	-1
18	10	13	6	4	-13	6	-11	-5	1
19	6	-1	-7	-11	-11	-14	-11	13	11
20	4	-14	-9	15	8	0	1	5	-3
21	6	-1	-9	12	-12	11	4	-8	4
22	1	-2	-2	7	-1	-10	-8	-3	2
23	3	-3	-4	5	-5	4	9	-10	1
24	1	-7	-8	11	-6	-15	-10	-3	6
25	14	12	3	0	-4	0	-4	-11	-10
26	16	1	14	5	1	-11	1	-4	11
27	8	-1	-15	-8	-11	0	-3	2	2
28	5	14	-9	12	-7	4	12	13	-15
29	3	3	3	-8	-12	15	14	3	-8
30	7	7	-3	-12	-6	2	10	-12	-2

Setting the reproductive level

Synthesize the project, implement it, create a test bench, prepare a report, possibly skipping some points.

Setting the reconstructive level

Synthesize the project, implement it, create a testbench, and prepare a report, possibly skipping some steps. Using third-party libraries of binary arithmetic modules for the residual class system is prohibited; i.e., you must create your own modules for performing arithmetic operations.

Creative level task

Synthesize the project, implement it, create a testbench, create firmware and flash it to the FPGA, and prepare a report. If using ready-made binary arithmetic modules, supplement the project with your own modules for performing arithmetic operations.

Security questions

1. Xilinx ISE 14.7 Integrated Development Environment
2. Circuit simulation
3. Implementation of the scheme
4. Flashing the circuit into FPGA
5. Specifics of the hardware description language
6. VHDL Project Structure
7. VHDL data types
8. Sequential and parallel processes in VHDL
9. Implementation of branching constructs in VHDL
10. Implementation of cyclic constructs in VHDL
11. Parameterized modules in VHDL
12. Signal attributes in VHDL

13. Modular design in VHDL
14. Addition and subtraction of binary numbers
15. Multiplication of binary numbers
16. Division of binary numbers
17. Comparison of binary numbers
18. Coding negative numbers in the binary number system
19. Representation of rational numbers in the binary number system
20. Digital filters
21. Direct discrete Fourier transform
22. Inverse discrete Fourier transform
23. Optimizing the power consumption of the circuit

A list of recommended literature on this topic

Main:

1. Innovative Course of Practical Training (Mathematical Modeling): Laboratory Workshop / Ministry of Education of the Russian Federation; Federal State Autonomous Educational Institution of Higher Education "North Caucasus Federal University"; author-compiler N. I. Chervyakov; author-compiler A. I. Galushkin; author-compiler M. G. Babenko; author-compiler V. A. Kuchukov. - Stavropol: SKFU, 2023. - 187 p. - [http : // biblioclub . ru / .](http://biblioclub.ru/) - Bibliography: p. 185

Additional:

1. Digital circuitry. From logic element to control system: Practical course: Field of study 09.06.01 - Computer science and computer engineering. Profile Mathematical modeling, numerical methods and software packages. Graduate qualification Researcher. Lecturer-researcher / compiled by N. I. Chervyakov, P. A. Lyakhov, A. I. Galushkin; North-Caucasian Federal University. - Stavropol: SKFU, 2015. - 191 p.
2. Chervyakov, N. I. (SKFU). Digital Circuit Engineering: Textbook: Field of study 09.06.01 - Computer Science and Engineering. Profile "Mathematical Modeling, Numerical Methods and Software Packages". Graduate Qualification - Researcher. Research Lecturer / N. I. Chervyakov, A. I. Galushkin; North-Caucasian Federal University. - Stavropol: SKFU, 2015. - 198 p.

Methodical:

1. Chervyakov, N. I. (SKFU). Digital Circuit Engineering: Textbook: Field of study 09.06.01 - Computer Science and Engineering. Profile "Mathematical Modeling, Numerical Methods and Software Packages". Graduate Qualification - Researcher. Research Lecturer / N. I. Chervyakov, A. I. Galushkin; North-Caucasian Federal University. - Stavropol: SKFU, 2015. - 198 p.

Internet resources

1. Official website of Xilinx [electronic resource] / [http :// www . xilinx . com](http://www.xilinx.com)

Practical work #7

Topic: "Power Consumption Optimization and High-Speed Circuit Synthesis"

The purpose of the work: “ to consolidate knowledge on the theoretical foundations of energy consumption optimization and the synthesis of high-speed circuits.”

Competencies being developed (part of the competencies is being developed) :

PC-1: Ability to demonstrate general scientific basic knowledge of mathematical and natural sciences, fundamental computer science and information technology; ability to apply modern programming languages and parallel data processing methods, operating systems, electronic libraries and software packages, network technologies in professional activities

Progress of work

1. Organizational moment (registration in the laboratory, review of safety rules for working on a computer, preparation of the workplace, launch of the Xilinx ISE 14.7 design environment)
2. Familiarization with the basic, additional, and methodological literature, as well as Internet sources, necessary for completing laboratory work.
3. Prepare a report on the laboratory work.
4. Project protection.
5. Completion of work (disabling the design environment, tidying up the workspace)

Theoretical part

See the list of recommended reading.

Equipment and materials: see Appendix 1.

Safety precautions: see Appendix 3.

Assignments for laboratory work

Abstract review of information (Internet) sources for the assignment.

1. Optimizing the power consumption of the circuit
2. High-speed circuit synthesis
3. Implementation of computational algorithms in the form of a finite state machine
4. BCD encoding
5. SBIS debugging bench
6. Non-synthesizable subset of the VHDL language
7. Procedures and functions in VHDL
8. IEEE VHDL library
9. Creating a ROM in VHDL
10. Creating RAM in VHDL
11. Creating a STACK structure in VHDL
12. Creating a QUEUE structure in VHDL

Please provide information sources and their contents as specified in the assignment. Text, hyperlinks, tables, figures, and any other information that facilitates viewing and protection of the presentation/report are permitted. Only open, publicly accessible sources of information that do not require copyright transfer or any other royalties are permitted.

Security questions

1. Optimizing the power consumption of the circuit
2. High-speed circuit synthesis
3. Implementation of computational algorithms in the form of a finite state machine
4. BCD encoding
5. SBIS debugging bench
6. Non-synthesizable subset of the VHDL language
7. Procedures and functions in VHDL

8. IEEE VHDL library
9. Creating a ROM in VHDL
10. Creating RAM in VHDL
11. Creating a STACK structure in VHDL
12. Creating a QUEUE structure in VHDL

A list of recommended literature on this topic

Main:

7. GOST R 50754-95. VHDL Digital Systems Hardware Description Language. Language Description. Moscow: Gosstandart of Russia, 1995.
8. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
9. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

Additional:

3. Xilinx FPGAs in the WebPACKISE environment / compiled by G.V. Malinin, S.V. Abramov, A.V. Serebryannikov. Cheboksary: Publishing house of Chuvashia University, 2013.

Methodical:

5. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
6. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

Internet resources

5. Electronic library "Wikipedia" [electronic resource] / <http://www.wikipedia.org>
6. Official website of Xilinx [electronic resource] / <http://www.xilinx.com>

Equipment, materials and software used to organize and conduct practical work

Equipment:

A computer class (laboratory, auditorium) with a number of working computers equal to the number of students in the group plus a teacher's workstation and with a performance level sufficient for mastering the subject.

Software:

Xilinx ISE Webpack edition 14.7, a very large-scale integrated circuit (VLSI) design environment

Text editor for report design (LibreOffice 4. x , 5. x or OpenOffice)

Operating system: Windows (version not lower than XP), Linux (Mint not lower than 17.2)

Contents of the laboratory report

The work is considered completed by the student and is credited by the teacher (with points awarded proportionally to the completed points of the report, i.e., it is not necessary for the report to contain all the points) upon submission in electronic form for defense (a paper printout is not required!!!) of a neatly formatted report file in .odt (OpenOffice, LibreOffice) or .doc (MicrosoftOffice) format, named according to the template (if the work does not comply, it will not be allowed to be defended):

FPGA _ LR (job number)_V (version number)_(last name).odt

The report file must contain the following elements in the specified order (keeping their numbers if some points are omitted): 0. A note on familiarization with safety precautions (rules of conduct in the computer lab (classroom, laboratory)).

This section must include the entry “I have read and agree to comply with the safety regulations for performing laboratory work and behavior in the computer lab (classroom, laboratory) _____ (full name), _____ date.”

1. Statement of the problem (full conditions in accordance with the selected option).
2. A detailed mathematical (set of formulas and explanatory text) or informational (verbal description of the algorithm) model of the problem solution. Screenshots of calculations performed using computer algebra systems (SciLab, Octave, Maxima, etc.) are acceptable for this section. The use of proprietary (commercial) computer algebra systems (MathCad, MatLab, etc.) is not recommended.
3. Test sets of input data and corresponding correct results to verify the program's functionality (this section **should include a manual solution to the problem with intermediate calculations**). Screenshots of calculations in computer algebra systems (SciLab, Octave, Maxima, etc.) are acceptable for this section. The use of proprietary (commercial) computer algebra systems (MathCad, MatLab, etc.) is not recommended.
4. Specifying the names, types and purposes of all variables and signals included in the mathematical or information model.
5. The main and auxiliary (if any) algorithms for solving the problem (a description of the algorithm in an algorithmic language, for example, Pascal, is acceptable).
6. Record the full names of the files that make up the project, indicating the purpose of each file (at a minimum, indicate the names and contents of files with the .vhd extension (what entities, procedures, functions they contain, what they do).
7. Complete source code of the project's VHDL programs (each file must contain information about the developer - full name, year, group, specialty, university).
8. RTL diagram of the project (from the Synthesize-XST section of the design environment).
9. Contents of the .syn file of the project synthesis and implementation report.
10. Power consumption of the circuit in Watts (contents of the XPowerAnalyzer tables of the design environment).
11. A screenshot or printout of the computer program's output using the entered test data from section 3 of the report. Specifically, in this section, you must compare the obtained results with the reference test solution and write "result matches reference solution."
12. Study of the model.
In this section, you need to write down several sets of input data (define them yourself) and the corresponding modeling results (if in section 11 a complete enumeration of all possible input data was carried out, then write “matches section 11 of the report”).
13. Conclusions on the work done.
Specify the capabilities, advantages, and disadvantages of the model, and provide examples of use.

Rules of conduct in the computer lab (classroom, laboratory)

1. Only persons familiar with the safety and health instructions, the rules of conduct, and the placement of information resources are allowed to work in the computer lab.
2. Students are permitted to work in the computer lab only in the presence of a teacher (engineer, laboratory assistant).
3. During group classes, outsiders may be present in the classroom only with the teacher's permission.
4. **Before starting work, you must:**
 - ensure that there is no visible damage at the workplace;
 - Place notebooks and textbooks on the table so that they do not interfere with your work on the computer;
 - adopt the correct working posture;
 - If the previous user's session has not been terminated, terminate it;
 - Enter registration information (if necessary).
5. **When working in a computer lab, it is strictly prohibited to:**
 - be in class in outerwear;
 - place clothes and bags at work places;
 - be in the classroom with food and drinks;
 - put books, notebooks, etc. on the keyboard;
 - be located to the side or behind the switched-on monitor;
 - connect or disconnect cables, touch connectors, wires and sockets;
 - move computers;
 - open the system unit;
 - try to fix equipment malfunctions on your own;
 - block the ventilation openings on the system unit and monitor;
 - banging on the keyboard, pressing keys aimlessly;
 - delete or move other people's files;
 - install and run computer games;
 - use Internet resources for non-educational purposes.
6. **While in the computer lab, you must:**
 - maintain silence and order, turn off mobile phones from speakerphone mode;
 - comply with all requirements of the teacher, engineer and laboratory assistant;
 - work only under your name and password;
 - adhere to the work regime (the duration of continuous work at the computer should not exceed two hours with a mandatory 10-minute break and eye exercises; the duration of intensive work with the keyboard should not exceed 30 minutes with subsequent hand exercises; the total duration of work should not exceed 4 hours per day);
 - If you experience eye pain, a sharp deterioration in visibility, an inability to focus or focus your gaze, pain in your fingers and hands, or increased heart rate, immediately leave your workplace, report the incident to your teacher, and consult a doctor;
 - After finishing work, close all active programs and correctly end the session;
 - leave the workplace clean.
7. **When working at a computer, it is necessary to maintain correct posture:**
 - the distance from the screen to the eyes is 70-80 cm (arm's length);
 - vertically straight back;
 - shoulders are down and relaxed;
 - feet on the floor and not crossed;

- elbows, wrists and hands at the same level;
- elbow, hip, knee, ankle joints at right angles.

8. If software errors or equipment failures occur, the student is obliged to immediately contact the teacher (engineer, laboratory assistant).

9. In the event of damage or failure of computer class equipment due to the user's fault, repair or replacement of the equipment is carried out at the user's expense.

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous
Educational Institution of Higher Education "North Caucasus Federal University"

GUIDELINES

on organizing and conducting independent work
in the discipline "**Innovative Training Practice Course (Mathematical
Modeling) / Инновационный курс практического обучения
(математическое моделирование)**"
for students in the field of study
02.04.01 "Mathematics and Computer Science"
direction (profile)
"Training Program for Electronic Information"

INTRODUCTION

The course “Innovative Training Practice Course (Mathematical Modeling) / Инновационный курс практического обучения (математическое моделирование)” is included in the bachelor’s degree program in the field 02.04.01 – “Mathematics and computer science” and is a mandatory part of the block of disciplines.

This course explores the application of mathematical tools to solving applied problems, approximating functions, solving differential equations with boundary conditions, and numerically calculating definite integrals and derivatives. To reinforce the material covered, students will complete practical assignments using modern information technologies.

The purpose of this course is to ensure the fulfillment of the requirements of the State Educational Standard "Mathematics and Computer Science", according to which a bachelor's degree must have the ability to use fundamental knowledge in the field of mathematical analysis, complex and functional analysis, algebra, analytical geometry, differential geometry and topology, differential equations, discrete mathematics and mathematical logic, probability theory, mathematical statistics and random processes, numerical methods, theoretical mechanics in future professional activities.

To consolidate the material studied, it is expected that practical tasks will be completed using modern mathematical packages, MahCad , Maple , MatLab .

This discipline is designed to promote the fundamentalization of education, strengthen mathematical knowledge and develop students' systems thinking, and study theoretical, methodological and practical problems of the formation, functioning and development of information systems.

1 Requirements for the level of mastery of the discipline content

As a result of mastering the discipline, the student should possess the following competencies:

Index	Formulation:
UK-1	Able to carry out a critical analysis of problematic situations based on a systems approach and develop an action strategy
PC-1	Able to demonstrate fundamental knowledge of mathematics and natural sciences, programming and information technology
PC-2	Able to conduct scientific research based on existing methods in a specific area of professional activity.
PC-3	Capable of conducting methodological and expert work in the field of mathematics and computer science

2 Organizational and methodological recommendations for mastering the discipline

Students' independent work is a crucial prerequisite for developing a scientific approach to learning. It is conducted before each practical and laboratory lesson and involves completing a specific assignment.

The prepared material and practical assignment are presented in notes.

Independent study (IS) is one of the active forms of learning.

Independent studies in the discipline "Innovative Training Practice Course (Mathematical Modeling) / Инновационный курс практического обучения (математическое моделирование)" have the following goals:

- to consolidate and deepen the knowledge acquired by students in lectures and laboratory classes;

- to instill practical skills in working with modern information technologies.

Independent studies are conducted in specialized classrooms equipped with computer technology and the ability to use Internet and library resources.

The proposed methodological recommendations contain information for students necessary for the preparation and conduct of laboratory classes in the discipline "Innovative Training Practice Course (Mathematical Modeling) / Инновационный курс практического обучения (математическое моделирование)", and can also be useful for officials whose responsibilities include working with organizational and administrative documents (ORD).

GOST R 51141-08 defines the ORD as a type of written document that records the resolution of administrative and organizational issues, as well as issues of management, interaction, support and regulation of the activities of government bodies, institutions, enterprises, organizations, their divisions and officials.

According to the All-Russian Classifier of Management Documentation (OKUD), ORD are classified into four groups:

- organizational and legal documentation (charters, regulations, rules, staffing schedules, instructions);
- administrative documentation (orders, instructions, decrees, decisions, directions);
- information and reference documentation (letters, telegrams, faxes, acts, protocols, reports and memos, etc.);
- documents on personnel (applications, personal cards, orders on personnel, etc.).

The preparation of the ORD is carried out in accordance with the requirements of GOST R 6.30-2003 "Unified documentation systems. Unified system of organizational and administrative documentation. Requirements for document preparation."

This standard establishes: the composition of document details; requirements for the execution of document details; requirements for document forms.

3 Methodological guidelines for students' independent work

The guidelines include the following sections:

- the purpose of the work;
- a task that must be completed by a student as a result of independent work;
- task options;
- the main theoretical provisions necessary for completing the assignment, they should be brief and contain references to literature in which these provisions are set out in a volume sufficient for completing independent work;
- stages of task completion with indication of specific deadlines for completion of each stage and the entire task as a whole;
- requirements for the design of the graphic and text parts of independent work;
- an example of completing one of the task options and preparing a report;
- bibliographic list of used sources.

To help students and monitor their independent work, teacher consultations are used.

Consultations are one of the forms of work of the department to provide pedagogically appropriate assistance to students in their independent work.

Consultations should be individualized. If clarification of common issues is needed for several students, group consultations are held.

Consultations are conducted with the aim of:

- clarification of questions that arise among students during independent study of educational material and completion of homework;
- deepening and consolidating knowledge on individual issues and topics of the discipline;
- providing methodological assistance in choosing methods of independent work.

Attendance at student consultations is voluntary. However, the instructor may call for interviews those students who do not demonstrate solid knowledge during their studies and who do not voluntarily participate in the consultations.

During the consultation, the teacher explains the most complex issues that are unclear to students and points out literature that covers them.

When consulting students, the teacher is obliged to become familiar with how they study the recommended literature, give instructions and advice on methods of working on the educational material, facilitating a deeper and more lasting assimilation of it

Consultations should not be additional classes or substitutes for them. Doing homework for students or with them is prohibited. Consultations should not become a form of cramming for tests and exams.

If during the consultation it becomes clear that the student's lack of understanding of the question is due to insufficient study of certain sections of the program, then the consultant is obliged to recommend that the student study them and monitor the degree of assimilation of these issues.

Consultations do not constitute a knowledge assessment. The student's knowledge of the subject matter demonstrated during the consultation should not influence their assessment of the course material in exams and tests.

4. Organization of students' knowledge control. Forms of students' knowledge control

Students' knowledge, skills, and abilities are monitored and assessed during laboratory classes, consultations, and exams. During assessments, the instructor evaluates the student's understanding of the course "Innovative Practical Training Course (Mathematical Modeling) " and their ability to apply management methods to solve specific problems.

Students' knowledge assessment can be carried out in the following forms:

- current knowledge control;
- intermediate knowledge control.

Current monitoring of students' knowledge aims to:

- to evaluate the work of each student in assimilation of the educational material, to identify shortcomings in his preparation and to provide practical assistance in eliminating them;

The main forms of current monitoring of students' knowledge are:

- oral control survey;
- written control blitz survey;
- protection of laboratory work;
- intermediate testing;
- checking lecture notes.

Oral assessments of students are conducted during lectures (and lab sessions). Based on these assessments, the instructor evaluates the student's preparation for the class.

Students complete a written quiz during lectures and labs scheduled by the instructor. Students provide written responses to questions posed by the instructor. The results are recorded in the student's journal. During labs, students' knowledge and practical skills are assessed on a 4-point scale. The grades received are recorded in the journal.

When reviewing lecture notes, the quality of their writing is analyzed. Errors are noted, the instructor's review evaluates the quality of note-taking, and provides recommendations for improving the quality of lecture note-taking.

Interim assessment in the discipline is carried out in the form of a credit test and a credit test with a grade.

5 Recommendations for working with literature and sources

The study of literature and sources must begin with reading the relevant chapters of textbooks, teaching aids or literature recommended as the main or additional material for the discipline “Innovative Training Practice Course (Mathematical Modeling) / Инновационный курс практического обучения (математическое моделирование)”, which directly or indirectly relate to the topic being worked on.

When studying literature and sources, students are advised to take brief notes. However, they should not rewrite the entire content of the topic being studied; they should only jot down the main ideas and, in their opinion, the most important thoughts. In certain cases, where important definitions, concepts, necessary factual material and examples, or statistical information related to the topic being studied are encountered, students should transcribe them as citations with full bibliographical references.

A summary of recommended literature and sources should be kept, with the collected materials divided into individual chapters and sections according to the curriculum. All references to the literature and sources used should be included.

An important step in working with recommended literature and sources is studying legislative and regulatory acts at the federal, regional, local, and departmental levels. When studying Decrees of the President of the Russian Federation, Laws and Codes of the Russian Federation, resolutions, regulations, recommendations, etc., students should identify any changes and additions that may have been made since their publication.

The basis of the technology for intensifying training on the platform of digital educational technologies are educational and illustrative materials (support notes) for the discipline "Information Systems Tools".

Working with educational and illustrative materials has the following stages.

1. Study of the theoretical foundations of the educational material in the classroom:

presentation of the material being studied by the teacher to students with an explanation based on the supporting notes;

2. Independent work:

Individual work of students on the supporting notes; frontal consolidation of the supporting notes' blocks.

3. First repetition - reproduction of the content of the given topic of the reference summary from memory.

4. Oral recitation of the supporting notes is a necessary stage of external speech activity in the assimilation of educational material.

5. The second repetition is mutual questioning and mutual assistance of students to each other.

The use of educational and illustrative materials allows us to generalize complex material and activate students' thinking.

It is important to remember that the most important thing for a student in independent work with recommended literature and sources is the formation of their own individual style, which can become the basis for future professional activity.

6 List of recommended literature

List of key literature:

1. GOST R 50754-95. VHDL Digital Systems Hardware Description Language. Language Description. Moscow: Gosstandart of Russia, 1995.
2. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
3. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.
4. B. Parhami, Computer Arithmetic: Algorithms and Hardware Designs, 2nd edition, Oxford University Press, New York, 2010.

List of additional literature:

1. Akushsky I.Ya., Yuditsky D.I. Machine arithmetic in residual classes. – M.: Soviet Radio, 1968.
 2. Modular parallel computing structures of neuroprocessor systems / N. I. Chervyakov, P. A. Sakhnyuk, A. V. Shaposhnikov, S. A. Ryadnov; Ed. N. I. Chervyakov. - M.: FIZMATLIT, 2003.
 3. Xilinx FPGAs in the WebPACKISE environment / compiled by G.V. Malinin, S.V. Abramov, A.V. Serebryannikov. Cheboksary: Publishing house of Chuvashia University, 2013.
 4. Tanenbaum E. Computer Architecture. 5th ed. - St. Petersburg: Piter, 2007.
 5. Amos Omondi, Benjamin Premkumar. Residue Number System. Theory and implementation. - London: Imperial College Press, 2007.
- 8.1.3. List of educational and methodological support for independent work of students in a discipline (module)
1. Bibilo P.N. Fundamentals of the VHDL language. 3rd ed., suppl. - M.: LKI Publishing House, 2014.
 2. Harris, D.M. and Harris, S.L. Digital Circuit Design and Computer Architecture. Moscow: Morgan Kaufman, 2013.

List of resources of the information and telecommunications network "Internet" required for mastering the discipline (module)

1. Electronic library "Wikipedia" [electronic resource] / <http://www.wikipedia.org>
2. Official website of Xilinx [electronic resource] / <http://www.xilinx.com>