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MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education
"NORTH CAUCASUS FEDERAL UNIVERSITY"

APPROVED BY

Acting Director of the Institute
Advanced Engineering
A.A. Porokhnya

WORK PROGRAM OF THE DISCIPLINE
"Principle and Application of MCU"

Field of study	11.03.02 Infocommunication Technologies and Communication Systems
Profile	Intelligent Data Processing in Infocommunication Systems and Networks
Year of start of training	2026
Form of study	Full-time
Implemented in a semester	4

Developed by

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1. Purpose and objectives of mastering the discipline (module)

The purpose of mastering the discipline is to form students' professional competencies aimed at

programming microprocessor devices for the design and operation of robotic and intelligent systems.

Objectives of mastering the discipline:

- systematization of fundamental knowledge on the general principles of software development of embedded real-time microprocessor systems;
- formation of a system of knowledge, skills and abilities in programming robotic and intelligent systems using programming tools;
- formulation of ideas for the configuration of microprocessor equipment and peripheral devices of robotic and intelligent systems.

2. Place of the discipline (module) in the structure of the educational program

The discipline belongs to block 1 "Disciplines (modules)" of the part formed by the participants of educational relations. Its development takes place in the 4th semester.

3. List of planned learning outcomes in the discipline (module) correlated with the planned results of the development of the educational program

Code, formulation of competence	Indicator code, wording	Planned learning outcomes in the discipline (module), characterizing the stages of the formation of competencies, indicators
OPK-4. Able to understand the principles of modern information technologies and use them to solve problems of professional activity	ID-1 OPK-4 uses information and communication technologies when searching for the necessary information.	Understands the general principles of the functioning of hardware, software and software and hardware of microprocessor technology;
	ID-2 OPK-4 designs a solution to a specific project task, choosing the best way to solve it, based on the current legal norms and available resources and restrictions.	understands technologies for the development and debugging of robotic and intelligent systems, including the use of cross-platform programming.
	ID-3 OPK-4 understands modern interactive software systems and basic methods of processing experimental data, including the use of standard software, general and special-purpose software packages.	Works with programmable logic controllers. Carries out software and hardware configuration of microprocessor equipment and peripheral devices of robotic and intelligent systems.
	ID-4 OPK-4 uses the capabilities of computer technology and software to solve problems of control and algorithmization of information processing processes.	Creates flowcharts of algorithms for the functioning of the developed software products.
	ID-5 OPK-4 is proficient in methods of computer modeling of physical processes in the transmission of information, engineering and computer graphics techniques.	Evaluates the computational complexity of the software products being developed

4. Scope of the academic discipline (module) and forms of control *

Scope of classes: total: 4 EC 144 academic hours	OFO, In acad. hours
Contact work:	
Lectures/from them practical training	-
Laboratory work/from them practical training	-
Practical training/of which practical training	42
Independent work	48
Forms of control	
Exam	54
Credit	-
Credit with a grade	-
Course work	no

* The discipline (module) provides for the use of e-learning, distance learning technologies (*unless otherwise established by the educational standard*)

5. The content of the discipline (module), structured by topics (sections) with an indication of the number of hours and types of classes

№	Section (topic) of the discipline and summary	Emerging competencies, indicators	Full-time				Current Forms control Academic Performance
			Contact work of students with the teacher / of them in the form of practical training, hours			Independent work, hours	
			Lectures	Practical exercises	Laboratory work		
1	Topic 1. Features of programming microprocessor systems. Levels of representation of a microprocessor system. Program model of a microprocessor. Microcontroller architecture. Typical composition of microcontrollers. Low-level programming. Practical work: Structure of microcontrollers	ID-1 OPK-4 ID-2 OPK-4 ID-3 OPK-4 ID-4 OPK-4 ID-5 OPK-4	-	4	-	6	Interview
2	Topic 2. Software development tools for embedded microprocessor systems. Purpose and classification of software development tools (IDE). Composition of a typical IDE. Comparative analysis of Arduino IDE, Microchip Studio, Keil uVision, STM32 Cube IDE. Domestic software development tools. Creation of a block diagram of algorithms for the functioning of developed software products and software documentation according to the USPD using IDE Practical work: Structure of the processor core of a microcontroller	ID-1 OPK-4 ID-2 OPK-4 ID-3 OPK-4 ID-4 OPK-4 ID-5 OPK-4	-	6	-	6	Interview

3	Topic 3. Organization of the computing process in real-time systems. Organization of the computing process using dispatching. Organization of interrupt processing. FreeRTOS real-time operating system. Organization of the computing process using RTOS Practical work: Structure of the processor core of a microcontroller	ID-1 OPK-4 ID-2 OPK-4 ID-3 OPK-4 ID-4 OPK-4 ID-5 OPK-4	-	8	-	6	Interview
4	Topic 4. Programming of drivers of microprocessor devices. Universal synchronous-asynchronous transceiver (USART). Implementation of serial information exchange using USART. Programming of RS485, RS232 interface drivers based on the ModBus protocol. Development of drivers for data exchange using proprietary protocols Practical work: Memory of programs and data microcontroller	ID-1 OPK-4 ID-2 OPK-4 ID-3 OPK-4 ID-4 OPK-4 ID-5 OPK-4	-	8	-	6	Interview
5	Topic 5. Programming of tasks related to the generation and processing of time parameters. Timers and event processors and their implementation in the structure of microcontrollers. Measurement of time intervals. Real-time clock. Built-in time measurement functions. Generation of pulse sequences with specified durations and repetition periods. Counting of events related to external signals and program results. Practical work: Memory of programs and data microcontroller	ID-1 OPK-4 ID-2 OPK-4 ID-3 OPK-4 ID-4 OPK-4 ID-5 OPK-4	-	8	-	6	Interview

6	Programming tasks related to analog signal processing. Devices, algorithms, accuracy of analog-to-digital conversions. Comparison of analog quantities. Digital-to-analog converters. PWM-Based Analog Signal Generation Hands-On: I/O Ports	ID-1 OPK-4 ID-2 OPK-4 ID-3 OPK-4 ID-4 OPK-4 ID-5 OPK-4	-	8	-	6	Interview
7	Topic 7. Complex debugging of software for microprocessor systems. Debug boards and debugging tools. Emulators. The JTAG interface and its use for software verification of a microprocessor device. In-circuit programming using the JTAG interface. Programming of microcontrollers using the SPI interface. Estimation of the computational complexity of the developed software products Practical work: Hardware ensuring reliable operation of the MC	ID-1 OPK-4 ID-2 OPK-4 ID-3 OPK-4 ID-4 OPK-4 ID-5 OPK-4	-	8	-	6	Interview
8	Topic 8. Programmable logic controllers Purpose of programmable logic controllers. Aries programmable logic controllers. General characteristics of PLC programming languages. PLC graphical programming languages. PLC text-based programming languages. PLC integrated programming environments Practical work: Hardware ensuring reliable operation of the MC	ID-1 OPK-4 ID-2 OPK-4 ID-3 OPK-4 ID-4 OPK-4 ID-5 OPK-4	-	8	-	6	Interview
	Exam preparation					54	
	TOTAL		-	42	-	48	

6. Fund of assessment tools for the discipline (module)

The Fund of Assessment Tools (CSF) for the discipline (module) "Programming of Microprocessor Systems" is based on the list of competencies to be mastered with the indication of indicators. The CSF provides objective control over the achievement of the planned learning outcomes. The CSF includes:

- description of indicators and criteria for assessing competencies at various stages of their formation, description of assessment scales;
- methodological materials that determine the procedures for assessing knowledge, skills, and (or) work experience that characterize the stages of competence formation (included in the methodological

guidelines for those types of work that are provided for by the curriculum and provide for the assessment of the formation of competencies);

- standard assessment tools necessary for assessing knowledge, skills and the level of competence formation.

The FAT is an appendix to this program of the discipline (module).

7. Methodical instructions for students on the development of the discipline

Starting work, each student should take into account the following provisions.

The discipline (module) is built on a thematic principle, each topic is a logically complete section.

The lecture material is devoted to the consideration of the key, basic provisions of the courses and the explanation of educational tasks submitted for independent work of students.

Practical work is carried out in order to consolidate the acquired information, acquire skills in programming microprocessor systems.

Independent work of students is aimed at independent study of additional material, preparation for laboratory classes, as well as the performance of all types of independent work.

For the successful development of the discipline, it is necessary to perform all types of independent work, using the recommended sources of information.

8. Educational, methodological and information support of the discipline

8.1. List of basic and additional literature necessary for mastering the discipline (module)

8.1.1. List of basic literature:

1. Bazhenov A. V., Bratchenko N. Yu., Grivennaya N. V. Programming of Embedded Microprocessor Systems: Textbook. Stavropol: NCFU Publ., 2022. 302 p., unlimited copies.

2. Novikov, Y. V.; Fundamentals of Microprocessor Technology: Textbook / Yu. - Fundamentals of Microprocessor Technology, 2022-07-28. - Electron. dan. (1 file). - Moscow : Internet University of Information Technologies (INTUIT), IPR Media, 2020. - 405 p. - Electronic. - The book is in the premium version of EBS IPR BOOKS. - ISBN 978-5-4497-0677-5, unlimited copies

3. Vodovozov A. M. Microcontrollers for Automation Systems [Elektronnyi re-urs] : uchebnoe posobie [Microcontrollers for automation systems] : a textbook. — Electron. Text data. — M. : In-fra-Engineering, 2016. — 164 c. — 978-5-9729-0138-8. — Mode of access: <http://www.iprbookshop.ru/51727.html>

4. Fundamentals of programming microprocessor controllers in digital systems of control of technological processes [Elektronnyi resurs] : uchebnoe posobie / V. S. Kudryashov, A. V. Ivanov, M. V. Alekseev [i dr.]. — Elektron. tekstovye dan-nye. — Voronezh : Voronezh State University of Engineering Technologies, 2014. — 144 c. — 978-5-00032-054-9. — Mode of access: <http://www.iprbookshop.ru/47437.html>

5. Shegal A. A. Primenenie programmnoy kompleksa Multisim dlya proektirovaniya ustroystva na mikrodniktakh [Application of the Multisim software complex for designing devices on microcontrollers] : laboratory practicum / A. A. Shegal ; ed. by V. I. Ievlev. — Electron. Tekstovye dannyye. — Yekaterinburg : Ural Federal University, EBS ASV, 2014. — 116 c. — 978-5-7996-1117-0. — Mode of access: <http://www.iprbookshop.ru/65968.html>

8.1.2. List of additional literature:

1. Aliev, M. T.; Microprocessors and microprocessor control systems. 8-bit processors of the AVR family: laboratory workshop / M.T. Aliev, T.S. Bukanova ; Volga State Technological University. - Yoshkar-Ola : PSTU, 2016. - 64 p. : schemes, tabl., ill. - <http://biblioclub.ru/>. - Bibliogr. in the book. - ISBN 978-5-8158-1775-3, unlimited copies

2. Bezuglov, D. A. Digital devices and microprocessors. Textbook / D. A. Bezuglov, I. V. Kaliyevka. - Izd. 2-e. - Rostov-on-Don: Feniks, 2008. - 468 p. : ill. - (Higher Education). - Bibliogr.: p. 464-465. - ISBN 978-5-222-13917-2

3. Khartov, V. Y. Microcontrollers AVR: a workshop for beginners. Khartov. - Moscow: MSTU, 2007. - 240 p. : ill. - Appendix: p. 231-238. - References: p. 239. - ISBN 978-5-7038-3051-2

4. Melnikov, E. V.; Fundamentals of Microprocessor Technology: Laboratory Practicum / E. V. Melnikov. - Fundamentals of Microprocessor Technology, 2026-09-20. - Electron. dan. (1 file). - Samara : Samara State Technical University, EBS ASV, 2020. - 47 p. - Electronic. - The book is in the premium version of EBS IPR BOOKS. - ISBN 2227-8397, unlimited copies

8.2. List of educational and methodological support for students' independent work in the discipline (module)

1. Guidelines for the implementation of practical work in the discipline "Programming of microprocessor systems". – Stavropol, NCFU, 2025.
2. Guidelines for students on the organization and conduct of independent work in the discipline "Programming of microprocessor systems". – Stavropol, NCFU, 2025.

8.3. List of resources of the information and telecommunication network "Internet" necessary for mastering the discipline (module)

1. [http:// biblioclub.ru/](http://biblioclub.ru/) University Library Online
2. <http://catalog.ncfu.ru/catalog/ncfu> – Official website of the Scientific Library of the FGAOU HE NCFU

9. List of information technologies used in the implementation of the educational process in the discipline (module), including a list of software and information reference systems

When reading lectures, computer equipment is used, demonstrations of presentation multimedia materials. At seminars and practical classes, students present presentations prepared by them during the hours of independent work.

Information reference systems:

Information and reference and information and legal systems used in the study of the discipline:

- 1 <http://catalog.ncfu.ru/catalog/ncfu> – Official website of the Scientific Library of the FGAOU HE NCFU.
- 2 <http://www.consultant.ru> – Official website of Consultant Plus
- 3 <https://www.mnr.gov.ru> – Official website of the Ministry of Natural Resources and Environment of the Russian Federation
- 4 Information and Legal Portal "Garant" - <http://www.garant.ru/>

Software:

- 1 Viola Workstation 10
- 2 Alt Workstation K
- 3 Viola "Server"
- 4 Office software package - P7-Office

10. Description of the material and technical base necessary for the implementation of the educational process in the discipline (module)

Lectures	Classroom for training sessions, equipped with multimedia equipment and technical teaching aids.
Practical exercises	A classroom for training sessions, equipped with computer equipment, software tools and debugging boards with samples of microcontrollers of various types.
Independent work	Room for independent work of students, equipped with computer equipment with the ability to connect to the Internet and the ability to access the electronic information and educational environment of the university

11. Features of mastering the discipline (module) by persons with disabilities

Students with disabilities are provided with special textbooks, teaching aids and didactic materials, special technical teaching aids for collective and individual use, the services of an assistant (assistant) who provides students with the necessary technical assistance, as well as the services of sign language interpreters and typhlo-sign interpreters.

The development of a discipline (module) by students with disabilities can be organized together with other students, as well as in separate groups.

The development of a discipline (module) by students with disabilities is carried out taking into account the characteristics of psychophysical development, individual capabilities and health status.

In order to ensure the accessibility of higher education under the educational program by persons with disabilities when mastering the discipline (module), the following is ensured:

1) for visually impaired persons:

- the presence of an assistant who provides the student with the necessary technical assistance, taking into account individual characteristics (helps to take a workplace, move, read and complete the task, including by writing down by dictation),

- written tasks, as well as instructions on the procedure for their implementation, are drawn up in enlarged font,

- special textbooks, teaching aids and didactic materials (with large print or audio files),

- individual uniform lighting of at least 300 lux,

- if necessary, the student is provided with a magnifying device to complete the task;

2) for persons with hearing disabilities:

- the presence of an assistant who provides the student with the necessary technical assistance, taking into account individual characteristics (helps to take a workplace, move, read and complete the task, including by writing down by dictation),

- the availability of sound-amplifying equipment for collective use is ensured, if necessary, the student is provided with sound-amplifying equipment for individual use;

- is provided with appropriate sound means of reproducing information;

3) for persons with disabilities with musculoskeletal disorders (including those with severe disorders of the motor functions of the upper extremities or the absence of upper limbs):

- written tasks are performed on a computer with specialized software or dictated to an assistant;

- At the request of the student, tasks can be performed orally.

12. Features of the implementation of the discipline using distance educational technologies and e-learning

According to Part 1 of Article 16 of the Federal Law of December 29, 2012 No 273-FZ "On Education in the Russian Federation", e-learning is understood as the organization of educational activities with the use of information contained in databases and used in the implementation of educational programs and information technologies, technical means, as well as information and telecommunication networks that ensure the transmission of this information through communication lines, the interaction of students and teachers. Distance educational technologies are understood as educational technologies implemented mainly with the use of information and telecommunication networks with indirect (at a distance) interaction of students and teachers.

The discipline can be implemented using distance learning technologies and e-learning in whole or in part. The components of the discipline's teaching materials (the discipline's work program, assessment and methodological materials, forms of certification), implemented using distance learning technologies and e-learning, contain an indication of their use.

When organizing educational activities with the use of distance educational technologies and e-learning, asynchronous and synchronous ways of interacting with participants in educational relations through the information and telecommunication network "Internet" may be provided.

When using distance learning technologies and e-learning, the schedule for the discipline indicates: ways of interaction between participants in educational relations through the information and telecommunication network "Internet" (videoconferencing, ET - electronic testing); links to the electronic information and educational environment of NCFU, to educational platforms and resources of other organizations to which open access is provided through the information and telecommunication network "Internet"; for synchronous learning - the time of online classes and teachers; for asynchronous learning - the authors of online courses.

When organizing interim certification using distance learning technologies and e-learning, the Methodological Recommendations for the Use of Technical Means That Ensure the Objectivity of Results in the Conduct of Interim and State Final Certification in Educational Programs of Higher Education - Bachelor's Degree Programs, Specialist Programs and Master's Degree Programs with the Use of Distance Educational Technologies (Letter of the Ministry of Education and Education of Russia dated 07.12.2020 No MN-19/1573-AN "On the Direction of Methodological Recommendations") are used.

The implementation of the discipline using e-learning and distance learning technologies is carried out using the electronic information and educational environment of NCFU, to which students have access

through the information and telecommunication network "Internet", or using the resources of other organizations, including platforms that provide services for video conferences, online meetings and distance learning (MTS-Link), as well as using the capabilities of social networks for communication between students and teachers.

Educational and methodological support of the discipline implemented with the use of e-learning and distance educational technologies includes a work program, teaching aids or a course of lectures presented in electronic form, guidelines for the implementation of various types of educational activities of students provided for by the discipline, and other educational materials posted in the information and educational environment of NCFU.