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MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution
higher education
NORTH CAUCASIAN FEDERAL UNIVERSITY

I APPROVED BY

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WORKING PROGRAM OF THE DISCIPLINE

Analog Electronic Technology

Direction of training	11.03.02 Infocommunication technologies and communication systems
Profile	Intelligent Data Processing in Infocommunication Systems and Networks
Year of commencement of studies	2026
Form of study	full-time
Implemented in a semester	3

Developed by

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1. The purpose and objectives of mastering the discipline (module)

The objective of mastering the discipline : to develop students' professional competencies in the field of modern circuit design of analog and digital telecommunication devices.

Objectives of mastering the discipline :

- 1) Systematization of fundamental knowledge in the principles of construction and operation of typical (basic) analog and digital circuit devices.
- 2) Developing skills to correctly use acquired knowledge to select the right circuit design solutions when developing telecommunication devices and systems.
- 3) Acquisition of skills in designing analog and digital circuit devices;
- 4) Development of basic circuit design training necessary for successful mastery of professional disciplines, as well as for subsequent project activities.

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

The discipline "Analog electronic technology" refers to the disciplines of the compulsory part, Block 1 of Discipline (modules) B1.O.15.

3. List of planned learning outcomes for the discipline (module), correlated with the planned learning outcomes for the educational program

Code, formulation of competence	Code, indicator formulation	Planned learning outcomes for the discipline (module), characterizing the stages of formation of competencies, indicators
OPK-1. Capable of using the principles, laws, and methods of natural science and mathematics to solve engineering problems.	ID-1 OPK-1 understands the fundamental laws of nature and the basic physical mathematical laws and methods of accumulation, transmission and processing of information.	Understands the fundamental laws of nature, physical phenomena and processes, basic physical methods and mathematical techniques used in the theory of electrical and radio circuits for storing, transmitting and processing information.
	ID-2 OPK-1 applies physical laws and mathematical methods to solve theoretical and applied problems.	Applies physical laws and methods to formalize the representation of physical phenomena and processes occurring in electrical and radio circuits.
	ID-3 OPK-1 uses knowledge of physics and mathematics when solving practical problems.	Uses knowledge of physics and the theory of electrical and radio circuits when solving practical engineering problems.
OPK-2. Capable of independently conducting experimental research and using basic techniques for processing and presenting the obtained data.	ID-3 OPK-2 understands the basic methods and means of conducting experimental research, standardization and certification systems.	Understands the basic methods and means of conducting experimental studies of electrical and radio technical circuits using computer technology.
	ID-4 OPK-2 selects measurement methods and tools and conducts experimental research.	Conducts experimental studies of electrical and radio circuits, selects the necessary methods and means of measurement.

Code, formulation of competence	Code, indicator formulation	Planned learning outcomes for the discipline (module), characterizing the stages of formation of competencies, indicators
	ID-5 ОПК-2 has methods for processing and presenting the obtained data and assessing the error of the measurement results.	Proficient in methods of processing and presenting obtained data and assessing the error of measurement results.

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

Amount of classes: total: <u>3</u> credits, <u>108</u> academic hours.	OFO, in academic hours
Contact work:	32.00
Lectures/including practical training	0
Laboratory work /including practical training	0
Practical classes /including practical training	32.00 / -
Independent work	76.00
Forms of control	
Exam	No
Credit	Yes
Credit and grade in the 5th semester	No
Calculation and graphic works	No
Coursework (projects) in the 6th semester	No

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

No.	Section (topic) of the discipline and brief content	Developed competencies, indicators	correspondence course		Forms of the current control
			Contact work of students with a teacher/of which in the form of practical training, hours	Independent work,	

							academic performance
			Lectures	Practical classes	Laboratory work		
1	Key technical indicators and characteristics of analog electronic devices. Principles of electrical signal amplification. Basic definitions. Classification of amplifying devices. Main technical parameters of an amplifier. Main technical parameters of an amplifier. Main characteristics of an amplifier. Principles of electrical signal amplification. Study of the parameters and characteristics of an amplifying device based on its circuit model for the variable component of the signal. Practical lesson No. 1 STUDY OF PARAMETERS AND CHARACTERISTICS OF AN AMPLIFIER DEVICE BASED ON ITS CIRCUIT MODEL FOR THE VARIABLE COMPONENT OF THE SIGNAL	OPK-1 ID-1o PC-1		2.00		4.00	Interview
2	Principles of construction of amplifying devices. Typical functional stages of a semiconductor amplifier: circuits for switching on, applying bias, and stabilizing the operating point. Aperiodic amplifier stages in small-signal mode. Research of voltage amplifiers on bipolar transistors. Practical lesson No. 2 STUDY OF VOLTAGE AMPLIFIERS	OPK-1 ID-1o PC-1		2.00		6:00	Interview
3	Feedback in amplifiers. General information about feedback in amplifiers. Amplifiers with series negative current and voltage feedback. Amplifiers with parallel negative current and voltage feedback. Combined negative feedback. Multi-stage amplifiers with negative feedback. Parasitic feedback in multi-stage amplifiers. Study of the influence of negative feedback on the characteristics of amplifying devices. Practical lesson No. 3	About PC-1 ID-2o PC-1 1		2.00		6:00	Interview

	STUDY OF THE INFLUENCE OF NEGATIVE FEEDBACK CONNECTIONS ON THE CHARACTERISTICS OF AMPLIFIER DEVICES						
4	Typical gain stages. Common-emitter (common-source) amplifier stage. Common-base and common-collector amplifier stages. Amplification of pulsed signals. Transformer amplifier stages. Study of aperiodic amplifying cascades. Practical lesson No. 4 STUDY OF APERIODIC AMPLIFIERS CASCADES	OPK-1 ID-2o PC-1		2.00		6:00	Interview
5	Amplifying stages with correction. Gain enhancement methods. Low-frequency correction. Simple parallel high-frequency correction. High-frequency correction using series negative current feedback (Z-type). Practical lesson No. 5 RESEARCH OF POWER AMPLIFIERS	OPK-2 ID-3o PC-2		2.00		6:00	Interview
6	Power amplifiers. General principles of power amplification. Transformerless stages. Transformer stages. Phase-inverting stages. Methods for improving output amplifier performance. Research of power amplifiers. Practical lesson No. 6 RESEARCH OF OPERATIONAL AMPLIFIERS	About PC-2 ID-1o PC-2		2.00		6:00	Interview
7	Multi-stage amplifiers. General information on multi-stage amplifiers. RC-coupled amplifiers. DC amplifiers. Practical lesson No. 7 STUDY OF FUNCTIONAL CIRCUITS BASED ON OPERATIONAL AMPLIFIERS	OPK-2 ID-2o PC-2		2.00		6:00	Interview
8	Operational amplifiers. General information, parameters, characteristics, and equivalent circuit of an operational amplifier. Operational amplifier circuit diagrams. Static errors of operational amplifiers. Research of operational amplifiers. Practical lesson No. 8 STUDY OF ACTIVE FILTERS ON OPERATIONAL AMPLIFIERS	OPK-2 ID-3o PC-2		2.00		6:00	Interview

9	Functional circuits based on operational amplifiers. Voltage adder. Differentiator and integrator. Logarithmic amplifier and exponential generator. Capacitance multiplier and resistance converter circuits. AC amplifier. Comparator. Analog multipliers and dividers using operational amplifiers. Research of functional circuits based on operational amplifiers. Practical lesson No. 9 RESEARCH OF AUTO GENERATORS	OPK-2 ID-4o PC-2		2.00		6:00	Interview
10	Active RC filters on operational amplifiers. General information about active filters. Analysis of passive RC filters. General description of a filter. Implementation of active filters. Frequency response shaping devices: gyrators, tone controls, and equalizers. Research of active filters on operational amplifiers. Practical lesson No. 10 RESEARCHING THE FUNDAMENTALS OF BOOLEAN LOGIC. MINIMIZATION LOGICAL FUNCTIONS	About PC-2 ID-5o PC-2		2.00		6:00	Interview
11	Analog electronic devices on integrated circuits. General information about integrated circuits. Features of analog integrated circuit technology. Amplifiers based on integrated circuits. Conclusion on the section "Circuitry of analog electronic devices." Practical lesson #11 RESEARCH OF BASIC LOGIC ELEMENTS	OPK-2 ID-3o PC-2		4.00		6:00	Interview
12	Counters and their application diagrams. General information about counters. Asynchronous counters. Synchronous counters with asynchronous carry. Applications of synchronous counters with asynchronous carry. Synchronous counters and their applications. Research of counters. Practical lesson #12 STUDY OF COMBINATIONAL DIGITAL DEVICES: ADDERS	OPK-2 ID-4o PC-2		4.00		6:00	Interview

13	Digital-to-analog and analog-to-digital converters. General information, classification, and parameters of analog-to-digital converters (ADCs). Parallel and serial-parallel ADCs. 3. Serial and integrating ADCs. General information, classification, and parameters of digital-to-analog converters (DACs). Serial DACs. Parallel DACs. Research of digital-to-analog and analog-to-digital converters. Practical lesson #13 STUDY OF COMBINATIONAL DIGITAL DEVICES: ENCRYPTORS AND DECODERS	OPK-2 ID-5o PC-2		4.00		6:00	Interview
	TOTAL for the semester			32.00		76.00	
	TOTAL			32.00		76.00	

6. Fund of assessment tools for conducting ongoing monitoring of academic performance and midterm assessment of students in a discipline (module)

The Assessment Toolkit (AT) for ongoing monitoring of student progress and midterm assessment in the course (module) " Analog Electronic Technology " is based on a list of competencies to be mastered, indicating the stages of their development during the course (module) mastery. The AT provides objective monitoring of the achievement of planned learning outcomes. The AT includes:

- description of indicators and criteria for assessing competencies at various stages of their formation, description of assessment scales;
- methodological materials defining the procedures for assessing knowledge, skills, abilities and (or) work experience, characterizing the stages of competence development;
- standard test assignments and other materials necessary for assessing knowledge, skills and the level of mastery of the developed competencies in the process of mastering the discipline (module).

FOS is an appendix to this discipline (module) program.

7. Methodological guidelines for students on mastering the discipline

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

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

The lecture material is devoted to the examination of key, basic provisions of the course and an explanation of the educational assignments assigned to students for independent work.

Laboratory work is carried out with the aim of consolidating the acquired information and acquiring skills for its application in solving practical problems in the relevant subject area.

Students' independent work is aimed at independent study of additional material, preparation for laboratory work, and completion of all types of independent work.

To successfully master the course, it is necessary to complete all types of independent work using the recommended sources of information.

8. Educational, methodological and informational support of the discipline

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

8.1.1. List of main literature:

Galochkin V.A. Circuitry of Analog and Digital Devices Electronic resource: study guide / V.A. Galochkin; ed. S.N. Eliseev. - Samara: Volga Region State University of Telecommunications and Informatics, 2016. - 441 p. - The book is in the basic version of the IPRbooks electronic library system. - ISBN 978-5-904029-51-7.

Galochkin V.A. Circuit Design of Telecommunication Devices. Part 2. Circuit Design of Digital Electronic Devices Electronic resource: Textbook / V.A. Galochkin; ed. S.N. Eliseev. - Samara: Volga Region State University of Telecommunications and Informatics, 2016. - 280 p. - The book is in the premium version of the IPR BOOKS electronic library system. - ISBN 2227-8397.

Novikov Yu.V. Introduction to Digital Circuit Engineering Electronic resource: textbook / Yu.V. Novikov. - Introduction to Digital Circuit Engineering, 2019-12-01. - Moscow: Internet University of Information Technologies (INTUIT), 2016. - 392 p. - The book is in the basic version of the IPRbooks electronic library system. - ISBN 5-94774-600-X.

Bastrakova M.I. Circuitry of Telecommunication Devices: Workshop / M.I. Bastrakova, V.V. Pavlov; Volga State Technological University. - Yoshkar-Ola: Perm State Technical University, 2019. - 52 p.: schematic, ill. - <http://biblioclub.ru/>. - Bibliography in the book - ISBN 978-5-8158-2073-9

Galochkin, V.A. Circuit Design of Telecommunication Devices. Guidelines for Laboratory Work. Part 1. Circuit Design of Analog Electronic Devices. Electronic resource: Textbook / V.A. Galochkin. - Samara: Volga Region State University of Telecommunications and Informatics, 2016. - 402 p. - The book is in the premium version of the IPR BOOKS electronic library system. - ISBN 2227-8397

Durkin V.V. Circuitry of Analog Electronic Devices. Electronic resource / Durkin V.V., Tyrykin S.V., Belorutsky R.Yu.: teaching aid. - Novosibirsk: NSTU, 2019. - 88 p. - ISBN 978-5-7782-3937-1

8.1.2. List of additional literature:

Belous I.A. Circuitry of Telecommunication Devices. Electronic resource / Belous I.A.: study guide. - Vladivostok: VSUES, 2018. - 56 p. - ISBN 978-5-9736-0516-2.

Kravets A.V. Textbook for the course "Circuitry of analog electronic devices": textbook / A.V. Kravets. - Rostov-on-Don|Taganrog: Publishing House of the Southern Federal University, 2018. - 185 p.: ill. - <http://biblioclub.ru/>. - Bibliography in the book. - ISBN.

Linets G.I. Circuitry of Telecommunication Devices: textbook: / G.I. Linets, A.V. Veligosha; North-Caucasian Federal University, Part 1, Analog Circuitry. - Stavropol: SKFU, 2015. - 198 p.

Loskutov E.D. Circuit Design of Analog Electronic Devices Electronic resource: Textbook / E.D. Loskutov. - Saratov: University Education, 2016. - 264 p. - The book is in the premium version of the IPR BOOKS electronic library system. - ISBN 2227-8397.

Mikushin A.V. Digital circuit design Electronic resource: monograph / V.I. Sedinin / A.V. Mikushin. - Novosibirsk: Siberian State University of Telecommunications and Informatics, 2016. - 319 p. - The book is in the basic version of the IPRbooks electronic library system. - ISBN 978-5-91434-036-7.

A teaching aid for the subject Circuitry of Telecommunication Devices Electronic resource / compiled by: V.V. Logvinov, O.V. Matveeva. - Moscow: Moscow Technical University of Communications and Informatics, 2016. - 46 p. - The book is in the premium version of the IPR BOOKS electronic library system. - ISBN 2227-8397.

Chervyakov N.I. Digital circuit design: Tutorial / N.I. Chervyakov, A.I. Galushkin; North-Caucasian fed. - Stavropol: SKFU, 2015. - 198 p.

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

Lecture notes for the course "Circuitry of Telecommunication Devices." Part 1. Analog Circuitry / For bachelors in the 11.03.02 "Infocommunication Technologies and Communication Systems" program / electronic resource, 2023.

Lecture notes for the course "Circuitry of Telecommunication Devices." Part 2. Digital Circuitry / For bachelors in the 11.03.02 "Infocommunication Technologies and Communication Systems" program / electronic resource, 2023.

Guidelines for laboratory work in the academic discipline "Circuitry of Telecommunication Devices." Part 1. Analog Circuitry / For bachelor's degree students in the 11.03.02 "Infocommunication Technologies and Communication Systems" program / electronic resource, 2023.

Guidelines for laboratory work in the academic discipline "Circuitry of Telecommunication Devices." Part 2. Digital Circuitry / For bachelor's degree students in the 11.03.02 "Infocommunication Technologies and Communication Systems" program / electronic resource, 2023.

Guidelines for independent work on the academic discipline "Circuitry of telecommunication devices" / For bachelors of the training program 11.03.02 "Infocommunication technologies and communication systems" / electronic resource, 2023.

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

To help radio amateurs: info@mic-ron.ru / Circuit Engineering Magazine - <http://mic-ron.ru/knigi/740.html>

National Open University INTUIT / Hardware. - https://intuit.ru/studies/courses?service=0&option_id=37&service_path=1

Digital microcircuits, transistors / Website. - <https://www.microshemca.ru/>

www.biblioclub.ru - Electronic library system "University Library Online"

www.eLibrary.ru - Scientific Electronic Library

www.iprbookshop.ru - IPRbooks Electronic Library System

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 giving lectures, computer technology is used to demonstrate presentation multimedia materials.

During laboratory work, students conduct research on analog and digital circuit devices using computer modeling software and industrial laboratory setups.

Information reference systems:

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

1.	To help radio amateurs: info@mic-ron.ru / Circuit Engineering Magazine - http://mic-ron.ru/knigi/740.html
2.	National Open University INTUIT / Hardware. - https://intuit.ru/studies/courses?service=0&option_id=37&service_path=1
3.	Digital microcircuits, transistors / Website. - https://www.microshemca.ru/

Software:

1.	NI LabView Teaching Only.
2.	NI Multisim Education or Electronics Workbench.
3.	PTC Mathcad
4.	Test control program "Ayren"

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

Lecture classes	The lecture hall is equipped with specialized furniture and technical teaching aids for presenting educational information to a large audience, including a laptop and a projector. Visual aids include topical presentations corresponding to the course syllabi.
Laboratory classes	A classroom equipped with equipment and technical teaching aids for presenting educational information: - interdisciplinary laboratory platform with the NI ELVIS II + Circuit Design software package – 10 pcs. (with the "Fundamentals of Radio Engineering and Telecommunications" laboratory complex, the "Fundamentals of Digital Engineering and FPGA Programming" laboratory module); - 12 workstations consisting of: PC Dell Intel Core i3-3240 3.4GHz/4096Mb/500Gb/DVD-RW/keyboard/mouse, monitor DELL E2014H. Connection to the Internet, access to the university's corporate network.
Independent work	A room for independent student work equipped with computers and the ability to connect to the Internet and access the university's electronic information and educational environment.
Practical training	It is carried out in the structural divisions of the university and (or) in organizations operating in the profile of the relevant educational program, including its structural division

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 (helper) who provides students with the necessary technical assistance, as well as the services of sign language interpreters and tactile sign language interpreters.

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

The acquisition 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 accessibility of higher education under the educational program for individuals with disabilities, the following is provided when mastering a discipline (module):

1) for persons with visual impairments:

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

- written assignments, as well as instructions on how to complete them, are written in large print,

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

- individual uniform illumination of at least 300 lux,

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

2) for persons with hearing impairments:

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

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

- is provided with appropriate sound means for reproducing information;

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

- written assignments are completed on a computer with specialized software or dictated to an assistant;

- at the student's request, assignments can be completed orally.

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

According to Part 1 of Article 16 of Federal Law No. 273-FZ of December 29, 2012, "On Education in the Russian Federation," *e-learning* is defined as the organization of educational activities using information contained in databases and used in the implementation of educational programs, as well as information technologies, technical means, and information and telecommunications networks that facilitate the transmission of said information over communication lines, as well as interaction between students and teaching staff. *Distance learning technologies* are educational technologies implemented primarily using information and telecommunications networks through indirect (remote) interaction between students and teaching staff.

The course may be delivered using distance learning technologies and e-learning, in whole or in part. The components of the course's teaching and methodological kit (the course curriculum, assessment and methodological materials, and assessment forms) implemented using distance learning technologies and e-learning contain instructions for their use.

When organizing educational activities using distance learning technologies and e-learning, asynchronous and synchronous methods of interaction between participants in educational relations may be provided through the Internet information and telecommunications network.

When using distance learning technologies and e-learning, the curriculum for the discipline shall indicate: methods of interaction between participants in educational relations via the Internet (videoconferencing, electronic testing); links to the SKFU electronic information and educational environment, to educational platforms and resources of other organizations that are openly accessible via the Internet; for synchronous learning - the time of online classes and teachers; for asynchronous learning - the authors of online courses.

When organizing midterm assessments using distance learning technologies and e-learning, the Methodological Recommendations for the Use of Technical Means Ensuring the Objectivity of Results during Midterm and State Final Assessments for Higher Education Programs—Bachelor's Degree Programs, Specialist Programs, and Master's Degree Programs Using Distance Learning Technologies—are used (Letter of the Ministry of Education and Science of Russia dated December 7, 2020, No. MN-19/1573-AN "On the Submission of Methodological Recommendations").

The implementation of the course using e-learning and distance learning technologies is carried out using the electronic information and educational environment of SKFU, to which students have access via the information and telecommunications network "Internet", or using the resources of other organizations, including platforms that provide services for video conferencing, online meetings and distance learning, as well as using the capabilities of social networks for communication between students and teachers.

The educational and methodological support for a discipline implemented using e-learning and distance learning technologies includes a work program, educational and methodological manuals or a course of lectures, methodological instructions for the implementation of various types of educational activities of students provided for by the discipline, and other educational and methodological materials posted in the information and educational environment of SKFU, presented in electronic form.