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Информация о владельце:

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MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION

Federal State Autonomous Educational Institution of Higher Education

NORTH CAUCASIAN FEDERAL UNIVERSITY

I APPROVED BY

Acting director of the institute

advanced engineering

Ph.D. tech. Sciences , Associate Professor

A.A. Porokhnya

WORKING PROGRAM OF THE DISCIPLINE

Digital Signal Processing/ Digital Signal Processing »

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	5

Developed by

Professor of the Department of Digital,
Robotic Systems and Electronics, Institute of
Advanced Engineering

Doctor of Technical Sciences, Professor
Linets G.I.

Stavropol 2026

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

The goal of this course is to acquire knowledge, skills, and abilities in the fundamentals of signal theory and the mathematical methods underlying modern signal processing algorithms. Particular attention is paid to spectral analysis and filtering techniques, which play an important role in the professional training of specialists in the 11.03.02 Infocommunication Technologies and Communication Systems program.

The objectives of mastering the discipline are:

- formation of clear ideas about the fundamental principles of digital signal processing theory;
- training in the basics of analytical and numerical methods for calculating and analyzing digital signal converters;
- development of skills in designing digital converters, processing experimental results and their analysis.

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

The course Digital Signal Processing (B1.0.28) is a compulsory part of Block 1.

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-2 _{OPK-1} applies physical laws and mathematical methods to solve theoretical and applied problems.	applies physical laws and mathematical methods to solve problems of a theoretical and applied nature.
	ID-3 _{OPK-1} uses knowledge of physics and mathematics when solving practical problems.	uses knowledge of physics and mathematics to solve practical problems.
OPK-2. Capable of independently conducting experimental research and using basic techniques for processing and presenting the obtained data.	ID-2 _{OPK-2} develops a solution to a specific problem, selecting the optimal option and evaluating its advantages and disadvantages.	develops a solution to a specific problem, choosing the optimal option and evaluating its advantages and disadvantages.
	ID-5 _{OPK-2} has methods for processing and presenting the received data and assessing the error of the measurement results	owns methods of processing and presenting obtained data and assessing the error of measurement results.
OPK-3. Capable of applying methods for searching, storing, processing, analyzing, and presenting information from various sources and databases in the required format, while	ID-2 _{OPK-3} understands the principles, basic algorithms, and devices of digital signal processing; the principles of constructing various types of telecommunication systems and methods of distributing information in communication networks.	understands the principles, basic algorithms and devices of digital signal processing; the principles of constructing telecommunication systems of various types and methods of distributing information in communication networks.

Code, formulation of competence	Code, indicator formulation	Planned learning outcomes for the discipline (module), characterizing the stages of formation of competencies, indicators
adhering to basic information security requirements.		

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

Number of classes: total: 4_z.e., 144 academic hours	OFO, in academic hours
Contact work:	34.00
Lectures/including practical training	0
Practical classes/including practical training	34.00
Independent work	110.00
Forms of control	
Exam	-
Credit	Yes
Credit with grade	-
Coursework	-
Tests	-

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

5.1. Thematic plan of the course (module)

No.	Chapter (topic) of the discipline and brief content	Developed competen- cies, indica- tors	full-time education				Forms of the current control academic per- formance
			Contact work of students with a teacher/of which in the form of practical train- ing, hours			Independent work, hours	
			Lectures	Practical classes	Laboratory work		
5th semester							
1	General characteristics of sig- nals. Basic concepts: information, message, signal. Mathematical model of an analog signal. Clas- sification of signals. Energy characteristics of signals. Repre- sentation of a deterministic sig- nal using simple functions. Rep- resentation of a deterministic signal using orthogonal func- tions. Discretization of analog	OPK-1 ID-2 OPK-1 ID-3 OPK-1 OPK-2 ID-2 OPK-2 ID-5 OPK-2 OPK-3 ID-2 OPK-3		2.00		12:00	interview

	signals. Discrete and digital sequences. Signal processing. Practical lesson No. 1 Harmonic analysis of periodic signals						
2	Harmonic analysis of periodic signals. Basic signal system. Trigonometric Fourier series. Complex (exponential) Fourier series. Spectra of simple periodic signals. Conditions for convergence of the Fourier series. The Gibbs phenomenon. Power distribution in the spectrum of a periodic signal. Practical spectral width. Practical lesson No. 2 Harmonic analysis of non-periodic signals	OPK-1 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-2 _{OPK-2} ID-5 _{OPK-2} OPK-3 ID-2 _{OPK-3}		4.00		12:00	interview
3	Harmonic analysis of non-periodic signals. Fourier transform. Spectral characteristics of simple non-periodic signals. Basic properties of the Fourier transform. Energy distribution in the spectrum of a non-periodic signal. Practical spectral width. Practical lesson No. 3 Signal decomposition According to the Laguerre function system	OPK-1 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-2 _{OPK-2} ID-5 _{OPK-2} OPK-3 ID-2 _{OPK-3}		4.00		12:00	interview
4	Spectral decomposition of signals by Laguerre and Walsh functions. Polynomials and Laguerre functions. Decomposition of signals in terms of Laguerre functions. Walsh functions and methods for ordering them. Decomposition of signals in terms of Walsh functions. Practical lesson No. 4 Signal decomposition According to the Walsh function system	OPK-2 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-2 _{OPK-2} ID-5 _{OPK-2} OPK-3 ID-2 _{OPK-3}		4.00		12:00	interview
5	Linear stationary systems. General concepts. Differential equation of a linear time-invariant system. Transfer function of a linear time-invariant system. Frequency transfer function and frequency characteristics of a linear time-invariant system. Impulse response function of a lin-	OPK-2 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-2 _{OPK-2} ID-5 _{OPK-2} OPK-3 ID-2 _{OPK-3}		4.00		12:00	interview

	ear time-invariant system. Stability of linear time-invariant systems. Practical lesson No. 5 Decomposition of signals using the Haar function system						
6	Analog filters. Filtration problems. Basic filters and their ideal frequency responses. Approximation problems. Typical low-pass filters. Butterworth filters. Chebyshev filters of the first kind. Denormalization and transformation of filters. Filter calculation examples. Practical lesson No. 6 Research of analog low-pass and high-pass filters	OPK-2 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-2 _{OPK-2} ID-5 _{OPK-2} OPK-3 ID-2 _{OPK-3}		4.00		12:00	interview
7	Discrete signal models. Typical discrete sequences. Description and transformation of discrete sequences. Representation of a discrete sequence as a discrete function of time. Discrete Laplace transform. Z-transform. Properties of the direct Z-transform. Inverse Z-transform. Fourier transform of a discrete signal. Discrete Fourier transform (DFT). Properties of the discrete Fourier transform. Signal reconstruction from its samples. Practical lesson No. 7 Representation of signals using Kotelnikov series	OPK-3 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-2 _{OPK-2} ID-5 _{OPK-2} OPK-3 ID-2 _{OPK-3}		4.00		12:00	interview
8	Linear discrete systems. The concept of a discrete system. Transfer function of a discrete system. Impulse response of a discrete system. Convolution control. Frequency transfer function of a discrete system. Amplitude and phase frequency responses. Structural diagrams of a discrete system. Stability of discrete systems. Discrete integration. Discrete differentiation. Practical lesson No. 8 Discrete integration and differentiation	OPK -3 ID-2 _{OPK-3} ID-3 _{OPK-3} OPK-2 ID-2 _{OPK-2} ID-5 _{OPK-2} OPK-3 ID-2 _{OPK-3}		4.00		12:00	interview
9	Principles of construction and classification of digital filters. Functional diagram of a digital filter. Advantages and disadvantages	OPK-3 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-2 _{OPK-2}		4.00		2:00 PM	interview

	vantages of digital filters. Classification of digital filters. Implementation of digital filters. Practical lesson No. 9 Smoothing of discrete sequences	ID-5 _{OPK-2} OPK-3 ID-2 _{OPK-3}					
	TOTAL for the semester			34.00		110.00	
	TOTAL			34.00		110.00	

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 performance monitoring and midterm assessment of students in the course (module) "Digital Signal Processing" is based on a list of mastered competencies, 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 courses 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:

1. Neches I. O. Digital signal processing. Electronic resource / Neches I. O.: study guide. - Rostov-on-Don: RGUPS, 2019. - 84 p. - ISBN 978-5-88814-893-8, unlimited copies.

2. Pasechnikov I.I. Digital signal processing Electronic resource / Pasechnikov I.I.: textbook. - Tambov: TSU im. G.R.Derzhavin, 2019. - 156 p. - ISBN 978-5-00078-261-3, unlimited copies.

3. Novikov P.V. Digital signal processing Electronic resource: teaching aid / P.V. Novikov. - Saratov: Vuzovskoe obrazovanie, 2018. - 75 p. - The book is in the basic version of the IPRbooks electronic library system. - ISBN 978-5-4487-0286-0, unlimited copies.

4. Vadutov O.S. Mathematical Foundations of Signal Processing. Workshop Electronic resource: Textbook / O. S. Vadutov. - Tomsk: Tomsk Polytechnic University, 2014. - 102 p. - The book is in the premium version of the IPR BOOKS electronic library system. - ISBN 2227-8397, unlimited copies.

8.1.2. List of additional literature:

1. Alan Oppenheim Digital Signal Processing [Electronic resource] / Oppenheim Alan, Shafer Ronald; trans. S. A. Kuleshov, E. B. Makhyanova, N. F. Orlova. - Electronic text data. - Moscow: Tekhnosfera, 2012. - 1048 p. - 978-5-94836-329-5. - Access mode: <http://www.iprbookshop.ru/26906.html>, unlimited copies.

2. Solonina A.I. Digital signal processing. Modeling in Simulink: a tutorial for universities / A.I. Solonina. - St. Petersburg: BHV-Petersburg, 2012. - 425 p.: ill.; 24. - (Tutorial). - Stamp: Rec. UMO. - Bibliography: pp. 417-418. - Subject index: pp. 421-425. - ISBN 978-5-9775-0686-1 – 15 copies.

3. Fedosov V. P. Digital signal processing in LabVIEW / V. P. Fedosov, A. K. Nesterenko; edited by Fedosov V. P. - M.: DMK, 2007. - 472 p.: ill. - App.: pp. 397-452. - Bibliography: pp. 454-455. - ISBN 5-94074-342-0 – 7 copies.

4. Umnyashkin S.V. Fundamentals of the Theory of Digital Signal Processing: a tutorial / S.V. Umnyashkin. - 4th ed., corrected. - Moscow: Tekhnosfera, 2018. - 528 p.: ill. - ISBN 978-5-94836-508-4; [Electronic resource]. - URL: <http://biblioclub.ru/index.php?page=book&id=496608>, unlimited copies.

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

- 1 Laboratory practical training in the discipline "Digital signal processing". Training direction 11.03.02 Infocommunication technologies and communication systems / compiled by Linets G.I.
- 2 Novikov, P.V. Digital Signal Processing Electronic resource: teaching aid / P.V. Novikov. - Saratov: University education, 2018. - 75 p. - The book is in the basic version of the IPRbooks electronic library system. - ISBN 978-5-4487-0286-0

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

- 1 <http://padabum.com/>
- 2 <http://www.dsps.ru/>

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 signal processing 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.	http://padabum.com/
2.	http://www.dsps.ru/

Software:

1.	Mathcad 15
2.	Matlab 6.5
3	Alt Workstation 10
4	Alt Workstation K
5	Alt "Server"
6	Office suite - P7-Office

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

The material and technical base ensures the implementation of all types of disciplinary and interdisciplinary training, laboratory, and research work of students (portable laptop, portable projector, computers with the necessary software and Internet access).

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	Auditorium 9-520, equipped with equipment and technical teaching aids for the presentation of 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 internet access, providing access to an electronic information and educational environment.
Practical Preparation	It is carried out in the structural divisions of the university and (or) in organizations that carry out activities 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 the Federal Law of December 29, 2012 No. 273-FZ "On Education in the Russian Federation" defines e-learning as the organization of educational activities using information contained in databases and used in the implementation of educational programs and information technologies, technical means, and information and telecommunication networks that ensure the transmission of said information via communication lines, interaction between students and teaching staff that ensure its processing.

Distance learning technologies are understood as educational technologies implemented primarily using information and telecommunication networks with indirect (at a distance) interaction between students and teaching staff.

The implementation of the discipline can be carried out using distance learning technologies and e-learning in whole or in part.

The components of the teaching and methodological kit of a discipline (the discipline's work program, assessment and methodological materials, certification 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 Application 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 the Russian Federation 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 providing services for video conferencing, online meetings and distance learning (MTS-Link), 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.