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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
Electromagnetic fields And waves /Electromagnetic Fields and
Waves"

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	4

Developed by

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Stavropol 2026

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

The purpose of mastering the discipline : the formation of a set of general professional competencies of a future bachelor in the field of training 11.03.02 "Infocommunication technologies and communication systems", profile: "Intelligent data processing in infocommunication systems and networks".

Objectives of mastering the discipline :

To develop students' knowledge, skills, and abilities in the field of electrodynamics, preparing them for solving problems:

- in technological activities for the application of the basic provisions and laws of electromagnetic field theory for the implementation of technological processes for exchanging information at a distance, taking into account the requirements for ensuring electromagnetic compatibility and safety;
- in project activities on computer modeling and experimental research of physical processes associated with electromagnetic fields and waves, for the implementation of modern trends in the development of information and communication technologies and systems.

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

The course "Fundamentals of the Theory of Electromagnetic Fields and Waves" (B1.O.23) is one of the disciplines in the compulsory part of Block 1 "Disciplines (modules)".

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 and the basic physical mathematical laws of electromagnetic field theory.
	ID-2 _{OPK-1} applies physical laws and mathematical methods to solve theoretical and applied problems.	Applies physical laws and mathematical methods to solve theoretical and applied problems.
	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-1 _{OPK-2} finds and critically analyzes the information necessary to solve the assigned task.	Finds and critically analyzes information necessary to solve a given problem.
	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-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 the electromagnetic field.
	ID-4 _{OPK-2} selects methods and means of measurements and conducts experimental research.	Selects methods and means of measurement and conducts experimental research.
	ID-5 _{OPK-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

Code, formulation of competence	Code, indicator formulation	Planned learning outcomes for the discipline (module), characterizing the stages of formation of competencies, indicators
		data and assessing the error of measurement results.

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

Amount of classes: total: 3 credits, 108 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	32.00/0
Independent work	76.00
Forms of control	
Exam	-
Credit	Yes
Credit with grade	-
Coursework	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	full-time education			Independent work, hours	Forms of the current control academic performance
			Contact work of students with a teacher/of which in the form of practical training, hours				
			Lectures	Practical classes	Laboratory work		
1	Topic 1. Introduction to the theory of electromagnetic field. 1. Introduction to the discipline "Electromagnetic fields and waves". 2. The electromagnetic field as a form of matter's	OPK-1 ID-1 OPK-1 ID-2 OPK-1 ID-3 OPK-1 OPK-2 ID-1 OPK-2 ID-2 OPK-2 ID-3 OPK-2 ID-4 OPK-2		4	-	14	interview

	existence. Basic characteristics of the electromagnetic field. 3. Electromagnetic parameters and classification of media. Laboratory work No. 1. Study of the capabilities of Mathcad and Electronics Workbench programs for modeling and studying electromagnetic fields.	ID-5 _{OPK-2}					
2	Topic 2. System of equations of electrodynamics. 1. Maxwell's equations in integral and differential forms. 2. Complete system of electromagnetic field equations. Laboratory work #2. Study of operations on vector characteristics of physical fields.	OPK-1 ID-1 _{OPK-1} ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-1 _{OPK-2} ID-2 _{OPK-2} ID-3 _{OPK-2} ID-4 _{OPK-2} ID-5 _{OPK-2}		4	-	14	interview
3	Topic 3. Boundary conditions at the interface between media. 1. Statement of the problem of determining the components of the field at the interface between media. 2. Boundary conditions for the normal components of the field vectors. 3. Boundary conditions for the tangential components of the field vectors. Laboratory work No. 3. Modeling and study of boundary conditions on the interface between media .	OPK-1 ID-1 _{OPK-1} ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-1 _{OPK-2} ID-2 _{OPK-2} ID-3 _{OPK-2} ID-4 _{OPK-2} ID-5 _{OPK-2}		4	-	14	interview
4	Topic 4. Wave phenomena at the interface between two media. 1. Incident of plane waves on the interface between two media. 2. Approximate boundary conditions. Surface effect.	OPK-1 ID-1 _{OPK-1} ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-1 _{OPK-2} ID-2 _{OPK-2} ID-3 _{OPK-2} ID-4 _{OPK-2}		4	-	14	interview

	Laboratory work #4. Study of the phenomenon of incidence of a plane electromagnetic wave on the interface between two media.	ID-5 OPK-2					
5	Topic 5. Radiation of electromagnetic waves. 1. Solution of Maxwell's equations for the field of an elementary electric emitter. 2. Parameters and characteristics of an elementary electric emitter. Laboratory work #5. Modeling and study of elementary electric and magnetic emitters.	OPK-1 ID-1 OPK-1 ID-2 OPK-1 ID-3 OPK-1 OPK-2 ID-1 OPK-2 ID-2 OPK-2 ID-3 OPK-2 ID-4 OPK-2 ID-5 OPK-2		4	-	14	interview
6	Topic 6. Models of elementary emitters. 1. Elementary magnetic emitter. 2. Elementary slot radiator. 3. Huygens element. Laboratory work #6. Modeling and study of an elementary slot radiator and a Huygens element.	OPK-1 ID-1 OPK-1 ID-2 OPK-1 ID-3 OPK-1 OPK-2 ID-1 OPK-2 ID-2 OPK-2 ID-3 OPK-2 ID-4 OPK-2 ID-5 OPK-2		4	-	14	interview
7	Topic 7. Electromagnetic waves in rectangular and circular waveguides. 1. Transverse electric and transverse magnetic fields in a rectangular waveguide. Characteristics of rectangular waveguides. 2. Transverse electric and transverse magnetic fields in a circular waveguide. Characteristics of circular waveguides. Laboratory work #7. Study of electromagnetic waves in a rectangular waveguide. Study of electromagnetic waves in a circular waveguide.	OPK-1 ID-1 OPK-1 ID-2 OPK-1 ID-3 OPK-1 OPK-2 ID-1 OPK-2 ID-2 OPK-2 ID-3 OPK-2 ID-4 OPK-2 ID-5 OPK-2		4	-	12	interview
8	Topic 8. Dielectric waveguides, optical fibers.	OPK-1 ID-1 OPK-1		4	-	12	interview

1. Statement of the problem of field analysis in a dielectric waveguide. 2. Fields in a dielectric waveguide. Optical waveguides. Laboratory work #8. Study of electromagnetic waves in a dielectric waveguide.	ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-1 _{OPK-2} ID-2 _{OPK-2} ID-3 _{OPK-2} ID-4 _{OPK-2} ID-5 _{OPK-2}					
TOTAL for the semester			32	-	108	

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) " Electromagnetic Fields and Waves " 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 discipline and the explanation of 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:

Yakovlev S. V. Electromagnetic fields and waves: textbook: Field of study: Infocommunication technologies and communication systems. Profile of study: Communication networks and communication systems. Bachelor's degree / S. V. Yakovlev; North-Caucasian Federal University. - Stavropol: SKFU, 2013. - 217 p.: ill., unlimited copies.

Yakovlev S.V. Electromagnetic fields and waves: a teaching aid (workshop). / S.V. Yakovlev; North-Caucasian Federal University. - Stavropol: SKFU, 2013. - 238 p.: ill., – 93 copies.

Panasyuk Yu. N. Electromagnetic fields [Electronic resource]: a textbook for students / Yu. N. Panasyuk, A. P. Pudovkin. - Electronic text data. - Tambov: Tambov State Technical University, EBS ASV, 2014. - 96 p. - 978-5-8265-1266-1. - Access mode: <http://www.iprbookshop.ru/63926.html>, unlimited copies.

8.1.2. List of additional literature:

Bessonov L.A. Theoretical foundations of electrical engineering. Electromagnetic field: textbook for bachelors / L.A. Bessonov. - 11th ed., revised. and additional - M.: Yurayt, 2014. - 317 p. - (Bachelor. Advanced course). - On the textbook the stamp: Additional MO. - Bibliography: p. 275-276. - ISBN 978-5-9916-3176-1, - 7 copies.

Astakhov V.I. Quasistationary electromagnetic fields in conducting shells / V.I. Astakhov. - Moscow: Fizmatlit, 2013. - 330 p.: ill., diagram., table. - Bibliography in the book. - ISBN 978-5-9221-1494-3; Also [Electronic resource]. - URL: <http://biblioclub.ru/index.php?page=book&id=275466>, unlimited copies.

Textbook and assignments for term paper on Electromagnetic fields and waves [Electronic resource] / compiled by V. M. Sedov. - Electronic text data. - Moscow: Moscow Technical University of Communications and Informatics, 2016. - 27 p. - 2227-8397. - Access mode: <http://www.iprbookshop.ru/61579.html>, unlimited copies.

Electromagnetic Field in a Rectangular Waveguide [Electronic resource]: Workshop No. 3 / compiled by A. B. Proshin. - Electronic text data. - Moscow: Moscow Technical University of Communications and Informatics, 2015. - 16 p. - 2227-8397. - Access mode: <http://www.iprbookshop.ru/63349.html>, unlimited copies.

Electromagnetic fields and waves: a collection of problems and exercises: a textbook / L.A. Bokov, A.E. Mandel, J.M. Sokolova, L.I. Shangina; Ministry of Education and Science of the Russian Federation; Tomsk State University of Control Systems and Radioelectronics (TUSUR). - Tomsk: Tomsk State University of Control Systems and Radioelectronics, 2014. - 185 p.: diagrams, ill. - <http://biblioclub.ru/>. - Bibliography in the book, unlimited copies.

Bokov L.A. Electrodynamics and Propagation of Radio Waves [Electronic resource]: study guide / L.A. Bokov, V.A. Zamotrinsky, A.E. Mandel. - Electronic text data. - Tomsk: Tomsk State University of Control Systems and Radioelectronics, 2013. - 410 p. - 978-5-86889-578-4. - Access mode: <http://www.iprbookshop.ru/72050.html>, unlimited copies.

Apollonsky S.M. Human Life Safety in Electromagnetic Fields Electronic resource: textbook / B.E. Sindalovsky / T.V. Kalyada / S.M. Apollonsky. - Human Life Safety in Electromagnetic Fields, 2020-03-02. - St. Petersburg: Polytechnic, 2016. - 264 p. - The book is in the basic version of the IPRbooks electronic library system. - ISBN 978-5-7325-1107-9, unlimited copies.

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

Goncharov D.G. Lecture notes on the academic discipline "Fundamentals of the Theory of Electromagnetic Fields and Waves": Direction of training "Infocommunication Technologies and Communication Systems": [Electronic resource]. - Stavropol: SKFU, 2023. - unlimited copies.

Goncharov D.G. Methodological recommendations for laboratory work on the academic discipline "Fundamentals of the theory of electromagnetic fields and waves": Direction of training "Infocommunication technologies and communication systems": [Electronic resource]. - Stavropol: SKFU, 2023. - unlimited copies.

Goncharov D.G. Methodological guidelines for independent work on the academic discipline "Fundamentals of the theory of electromagnetic fields and waves": Direction of training "Infocommunication technologies and communication systems": [Electronic resource]. - Stavropol: SKFU, 2023. - unlimited copies.

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

Online calculator and reference book website. - Access mode - <http://ru.solverbook.com/>

Physics website. – Access mode: <http://www.physel.ru>

A portal for radio amateurs. – Access mode: <http://www.radioman-portal.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 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. Online calculator and reference book website. - Access mode - <http://ru.solverbook.com/>
2. Physics website. – Access mode: <http://www.physel.ru>
3. A portal for radio amateurs. – Access mode: <http://www.radioman-portal.ru/>

Software:

- 1 Alt Workstation 10
- 2 Alt Workstation K
- 3 Alt "Server"
- 4 Office suite - P7-Office

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

Lecture classes	The classroom for lecture-type classes is equipped with specialized furniture and technical teaching aids used for presenting educational information to a large audience: a laptop, a projector.
Laboratory classes	The classroom is equipped with the necessary equipment and technical means for presenting educational information: - Epson short-throw multimedia projector with a wall mount, single-element 120x240 whiteboard; - 15 workstations consisting of: Lenovo IdeaCentre i5-3330s-2.7 all-in-one PC/4Gb RAM/1Tb HDD, 615M video card/DVD/keyboard/mouse. Internet connection, 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 training	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 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 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.