

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

I APPROVE

Dean of the Faculty of Mathematics
and computer science named after
Professor N.I. Chervyakov,
Candidate of Physical and Mathematical
Sciences, Associate Professor
Grobova T.A.

WORKING PROGRAM OF THE DISCIPLINE
Engineering Mathematics / Инженерная математика

Direction of training	02.04.01 Mathematics and Computer Science
Directionality (profile)	Training Program for Electronic Information
Year of commencement of studies	2026
Form of study	full-time
Implemented in a semester	1

Developed by

Associate Professor of the Department of Computing
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Candidate of Physical and Mathematical Sciences,
Associate Professor
Tarasenko E.O.

1. The purpose and objectives of mastering the discipline

The purpose of the course : the formation of general professional competencies (OPK-1) of a future bachelor in the field of training 02.04.01 Mathematics and computer science .

Objectives of the discipline :

- development of professional knowledge, skills and abilities in using mathematical apparatus, programming methodology and modern computer technologies to solve practical problems of obtaining, storing, processing and transmitting information;
- fostering a mathematical culture that implies a clear understanding of the necessity and importance of mathematical training for a specialist in the field of computer science;
- familiarization with the main objects of numerical methods, as well as their applications for solving various problems requiring the use of such tools

2. The place of the discipline in the structure of the educational program

The course "Engineering Mathematics / Инженерная математика" is a mandatory part of the curriculum. It is taught in the 1 th semesters.

3. A list of planned learning outcomes for the discipline, correlated with the planned learning outcomes for the educational program

Code, formulation of competence	Code, indicator formulation	Planned learning outcomes for the discipline, characterizing the stages of formation of competencies, indicators
OPK-2. Able to create and explore new mathematical models in the natural sciences, improve and develop concepts, theories and methods	ID-1 _{OPK-2} Conducts research into new mathematical models in the natural sciences ID-1 _{OPK-2} Develops new and improves existing concepts, theories and methods	Able to use fundamental knowledge in the field of numerical methods in future professional activities. Possesses skills in using numerical methods to solve professional problems.
PC-1 Able to demonstrate fundamental knowledge of mathematics and natural sciences, programming and information technology.	ID-1 _{PC-1} In his professional activities, he demonstrates fundamental knowledge of mathematics and natural sciences. ID-2 _{PC-1} Solves problems of professional activity using programming and information technology tools	Uses knowledge of mathematical apparatus to solve professional problems. Operates with knowledge of methods of mathematical modeling of physical processes Able to construct rigorous logical proofs and calculations. Able to highlight the physical essence in applied problems. Has experience working with mathematical tools. Operates with knowledge of the syntax of modern programming languages (e.g. Python, C++). Operates with knowledge of basic algorithms and data structures. Able to develop algorithms to solve practical problems. Able to write, test and debug software code. Able to select IT tools for a specific problem. Possesses professional-level programming skills. Has experience working in special-

Code, formulation of competence	Code, indicator formulation	Planned learning outcomes for the discipline, characterizing the stages of formation of competencies, indicators
		ized development environments. Possesses methods of computer modeling and data analysis.

4. Volume of the academic discipline and forms of control *

Number of classes: total: 4 credits, 144 academic hours.	OFO, in academic hours
Contact work:	32.00
Lectures/including practical training	0.00
Laboratory work /including practical training	32.00
Practical classes /including practical training	0
Independent work	112.00
Forms of control	-
Exam	-
Credit 1 semester	-
Credit with grade	-
Coursework	No

* The course involves the use of e-learning and distance learning technologies

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

No.	Section (topic) of the discipline and brief content	Formed competencies, indicators	full-time education				Forms of ongoing monitoring of academic performance
			Contact work students with teacher/of which in uniform practical training, hours			Independent work, hours	
			Lectures	Practical classes	Laboratory work		
1st semester							
1.	Introduction to Numerical Methods. Introduction to Elementary Error Theory 1. Subject of computational mathematics. 2. Method of computational mathematics. 3. Classification of numerical methods. 4. Correctness and stability. 5. Technology of solving problems on a computer. 6. Approximate numbers. 7. Absolute and relative errors. 8. Rules for writing approximate numbers. 9. Relationship between the relative error of an approximate number and the number of correct digits of this number. 10. Rounding. 11. Error of a function. 12. Errors in arithmetic operations.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work

2.	Interpolation by unequal nodes 1. Statement of the problem of approximation (approximation) of functions. 2. Interpolation of functions as a method of approximation of functions. 3. Lagrange's interpolation formula. 4. Divided differences of different orders. 5. Newton's interpolation formula. 6. Error of interpolation formulas.	ID-1 OPK-2 ID-2 OPK-2 ID-1 PC-1 ID-1 PC-1		2.00		7:00	Defense of laboratory work
3.	Interpolation of functions by equally spaced nodes 1. The concept of finite differences. 2. Newton's first interpolation formula. 3. Newton's second interpolation formula. 4. Error estimates for Newton's interpolation formulas.	ID-1 OPK-2 ID-2 OPK-2 ID-1 PC-1 ID-1 PC-1		2.00		7:00	Defense of laboratory work
4.	Minimizing the Error of the Interpolation Method. Chebyshev Polynomials and Their Properties 1. Statement of the problem of minimizing the interpolation error. 2. Chebyshev polynomials and their properties. 3. Estimation of the interpolation error. 4. Convergence of the interpolation process.	ID-1 OPK-2 ID-2 OPK-2 ID-1 PC-1 ID-1 PC-1		2.00		7:00	Defense of laboratory work
5.	Spline interpolation 1. The concept of a spline. 2. Construction of a cubic spline. 3. Convergence of the interpolation process by cubic splines.	ID-1 OPK-2 ID-2 OPK-2 ID-1 PC-1 ID-1 PC-1		2.00		7:00	Defense of laboratory work
6.	Approximation of functions using the least squares method (Discrete version) 1. Statement of the problem. 2. Least squares method. 3. Examples of constructing functional dependencies based on experimental data.	ID-1 OPK-2 ID-2 OPK-2 ID-1 PC-1 ID-1 PC-1		2.00		7:00	Defense of laboratory work

7.	Least squares method in the case of an interval (Integral method) 1. Integral method of function approximation. 2. General problem of approximation by the least squares method. 3. Mean square approximations using trigonometric polynomials.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work
8.	Numerical differentiation 1. Statement of the problem of numerical differentiation. 2. Incorrectness of the problem of numerical differentiation. 3. Formulas of numerical differentiation. 4. On the computational error of formulas of numerical differentiation. 5. Improving the approximation. 6. Runge-Romberg method.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work
9.	Numerical integration 1. Statement of the numerical integration problem. 2. Basic concepts and definitions. 3. Methods of numerical integration: rectangle method, trapezoid method, Simpson's method (parabolas). 4. Residual terms and their estimates. 5. Newton-Cotes formulas. 6. Examples of calculating definite integrals. 7. Gauss-type quadrature formula. 8. Calculation of integrals with singularities. 9. Integration of strongly oscillating functions	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work
10.	Solution of nonlinear scalar equations 1. Statement of the problem. 2. Separation of roots. 3. The bisection method. 4. The method of simple iterations. 5. Newton's method. 6. Error assessment of equation solving methods.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work

11.	Direct methods for numerical solution of systems of linear algebraic equations 1. Gauss's method. 2. Khaletsky's scheme. 3. Square root method. 4. Sweep method. 5. Methods for calculating determinants.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work
12.	Iterative methods for numerical solution of systems of linear algebraic equations 1. The concept of normed space. 2. The method of simple iteration (Jacobi method). 3. The Seidel method. 4. The relaxation method. 5. The steepest descent method.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work
13.	Numerical solution of systems of nonlinear equations 1. Simple iteration method. 2. Newton's method. 3. Error estimation of simple iteration and Newton's methods.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work
14.	Numerical solution of the Cauchy problem 1. General information about the Cauchy problem. 2. Euler's method. 3. Error of the Euler method. 4. Modification of the Euler method. 5. Construction of Runge-Kutta methods. 6. Error estimation. 7. Runge-Kutta methods for solving systems of first-order differential equations. Solutions of higher-order differential equations by the Runge-Kutta method.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work
15.	Numerical solution of boundary value problems for ODEs 1. Statement of the problem 2. Finite difference method for second-order linear differential equations 3. Sweep method.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work

16.	Solution of partial differential equations 1. Difference schemes. Basic concepts. 2. Convergence and approximation of difference schemes. 3. Relationship between approximation and stability with convergence.	ID-1 _{OPK-2} ID-2 _{OPK-2} ID-1 _{PC-1} ID-1 _{PC-1}		2.00		7:00	Defense of laboratory work
	TOTAL for 1 semester			32.00			
	TOTAL			32.00			

6. Fund of assessment tools for the discipline

The Assessment Toolkit (AT) for the course "Engineering Mathematics / Инженерная математика" is based on a list of competencies to be mastered, indicating the stages of their development during the course. 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 program.

7. Methodological guidelines for students on mastering the discipline

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

The course "Engineering Mathematics / Инженерная математика" is structured on a thematic basis, with each topic representing a logically complete section.

Practical work is aimed at acquiring practical experience in the relevant subject area.

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

To successfully master the discipline, 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

8.1.1. List of main literature:

1. Zenkov A.V. Numerical methods: textbook / A.V. Zenkov. - Ekaterinburg: Publishing house of the Ural. University, 2016. - 124 p.

2. Kalitkin, N. N. Numerical Methods: A Textbook / N. N. Kalitkin; edited by A. A. Samarskii. - 2nd ed. - St. Petersburg: BHV-Petersburg, 2014. - 586 p.: ill. - (Educational Literature for Universities). - Approved by the Scientific and Methodological Council. - Bibliography: pp. 575-581 (129 titles). - Subject index: pp. 582-586. (10 copies): [Electronic resource].

8.1.2. List of additional literature:

1. Kireev V. I. Numerical methods in examples and problems: [a textbook for university students studying in the field of "Applied Mathematics"] / V. I. Kireev, A. V. Panteleev. - 4th ed., corrected. - St. Petersburg [and others]: Lan, 2015. - 448 p.

2. Pirumov, U. G. Numerical Methods: Theory and Practice: A Textbook for Bachelors / U. G. Pirumov; Moscow Aviation Institute (National Research University). - 5th ed., revised and enlarged. - Moscow: Yurait, 2012. - 421 p. - (Bachelor. Basic Course). - Stamp: Add. MO. - Bibliography: p. 416.

3. Srochko V. A. Numerical methods: a lecture course: [for students of higher educational institutions studying in the specialty 010200 "Applied Mathematics and Computer Science" and in the direction 510200 "Applied Mathematics and Computer Science"] / V. A. Srochko. - St. Petersburg [and others]: Lan, 2016. -- 208 p.

8.2. List of educational and methodological support for independent work of students in the discipline

1. Guidelines for completing laboratory work in the discipline "Engineering Mathematics" (electronic resource)

2. Guidelines for organizing and conducting independent work in the discipline "Engineering Mathematics" (electronic resource)

8.3. List of resources of the information and telecommunications network "Internet" necessary for mastering the discipline

1. Bazhenova I.Yu. Introduction to programming [Electronic resource]: textbook / I.Yu. Bazhenova, V.A. Sukhomlin. - Electronic text data. - Moscow, Saratov: Internet University of Information Technologies (INTUIT), University education, 2017. - 327 p. - URL : <http://www.iprbookshop.ru/67397.html>

2. Ivanov A.P., Poznyak L.T. Workshop on numerical methods. Calculation functions . URL: <http://www.apmath.spbu.ru/ru/structure/depts/is/task1-2013.pdf> .

3. Pimenov V.G. Numerical Methods: in 2 parts. Part 2: [study guide] / V.G. Pimenov, A.B. Lozhnikov; [scientific ed. Yu.A. Melentsova] ; Ministry of Education and Science of the Russian Federation, Ural. Federal University. – Ekaterinburg: Publishing house of Ural. University, 2014. – 106 p. – URL: https://elar.urfu.ru/bitstream/10995/31219/1/978-5-7996-1342-6_2014.pdf .

4. Numerical Methods . Part 1. URL : <https://teach-in.ru/course/numerical-methods-part-1>

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

Lectures are delivered using computers and multimedia presentations. In lab classes, students present presentations they prepared during independent work hours.

Information reference systems:

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

1.	https://ru.wikipedia.org/wiki/ Computational_methods Wikipedia is the free encyclopedia.
2.	http://www.intuit.ru/studies/courses/2317/617/info Numerical methods: National Open University INTUIT

Software:

1	Operating system: Microsoft Windows (latest version)
2	Base plastic bag Microsoft Office programs (Word, Excel, PowerPoint)
3	Maple Microsoft Office Standard 2013 (agreement No. 01- ea / 13 dated February 25, 2013, license No. 61541869)

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

Practical classes	A classroom for conducting classes, equipped with multimedia equipment and technical teaching aids
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.

11. Features of mastering the discipline 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 the discipline by students with disabilities can be organized jointly with other students, as well as in separate groups.

The acquisition of the discipline 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 the discipline:

- 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, and interaction between students and teaching staff. *Distance educational technologies* are educational technologies implemented primarily using information and telecommunications networks with indirect (at a distance) 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 following is indicated in the curriculum for the discipline:

methods for implementing interaction between participants in educational relations through the information and telecommunications network "Internet" (VKS - video conferencing, ET - electronic testing);

links to the electronic information and educational environment of SKFU, to educational platforms and resources of other organizations, to which open access is provided through the information and telecommunications network "Internet";

for synchronous learning - time of online classes and teachers;

For asynchronous learning - online course authors.

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 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.