

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution for Higher Education
«North-Caucasus Federal University»

APPROVED BY

Dean of FPE of NCFU
Candidate of Technical Sciences,
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COURSE SYLLABUS
«Engineering Mathematics»

Field of study	<u>13.04.02 Electric Power Engineering and Electrical Engineering</u>
Specialization (Profile)	<u>Training Program of Electrical Engineering</u>
Year of commencement of studies	<u>2026</u>
Mode of study	<u>full-time</u>
Implemented in semester(s)	<u>1</u>

DEVELOPED BY:

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

The goal of mastering the discipline is to form the mathematical foundation required for graduate-level study in electrical power engineering and electrical engineering; to develop the ability to analyze engineering problems, decompose them into mathematical models, and apply computational methods to solve practical tasks in power systems, power electronics, control, signal processing and data-driven engineering.

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

The discipline "Engineering Mathematics" belongs to the part formed by the participants of educational relations within the educational program. It is studied in the 1st semester.

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

Competency code and formulation	Indicator code and formulation	Planned learning outcomes for the discipline (module) describing the stages of competency and indicator formation
UC-1 Capable of conducting critical analysis of problem situations based on a systems approach and developing an action strategy	ID-2 UC-1 Analyses a problem situation and performs its decomposition into individual tasks	Decomposes engineering problems into mathematical variables, assumptions, equations and computational stages; selects appropriate methods of linear algebra, calculus, differential equations, Fourier analysis, numerical computation, optimization and statistics to obtain and interpret solutions.

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

Total study load: 3 credits / 108 academic hours	In academic hours
Contact work:	36
Lectures / of which practical training	0 / 0
Laboratory works / of which practical training	0 / 0
Practical classes / of which practical training	36 / 0
Independent work	72
Forms of control:	
Exam	—
Pass/Fail (Credit)	1st semester
Graded Pass/Fail (Credit with grade)	—
Course project/paper	—

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

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

№	Section (topic) of the discipline and brief content	Formed competencies and indicators	Full-time form				Forms of ongoing progress control
			Contact work of students with the teacher / of which in the form of practical training, hours			Independent work, hours	
			Lectures	Practical classes	Laboratory works		
1	Section 1. Linear Algebra. Topic 1.1. Vectors and matrices. Matrix operations. Brief content: vector spaces and basic operations with vectors; matrix types; matrix addition, multiplication and transposition; inverse matrix; use of matrices for representing engineering data and electrical network parameters.	ID-2 UC-1	–	2	–	4	Interview
2	Topic 1.2. Systems of linear equations. Gaussian elimination. Brief content: formulation of systems of linear algebraic equations; Gaussian elimination; pivoting; matrix form of engineering balance equations; interpretation of solutions in electrical engineering problems.	ID-2 UC-1	–	2	–	4	Interview
3	Topic 1.3. Eigenvalues and eigenvectors. Diagonalization. Brief content: eigenvalue problem; characteristic equation; eigenvectors and diagonalization; interpretation of modal properties; applications to stability, oscillations and dynamic models of engineering systems.	ID-2 UC-1	–	2	–	4	Interview
4	Section 2. Mathematical Analysis and Differential Equations. Topic 2.1. Functions of one and several variables. Derivatives. Brief content: functions, limits and continuity; partial derivatives; gradient; differential and sensitivity analysis; use of derivatives for describing changes in technical systems.	ID-2 UC-1	–	2	–	4	Interview
5	Topic 2.2. Integrals and Taylor series. Brief content: definite and indefinite integrals; numerical and analytical interpretation of integration; Taylor series expansion; local approximation of nonlinear functions in engineering calculations.	ID-2 UC-1	–	2	–	4	Interview
6	Topic 2.3. Ordinary differential equations. Brief content: first-order and higher-order ordinary differential equations; initial-value problems; analytical solution methods; examples of transient processes in electrical circuits and control systems.	ID-2 UC-1	–	2	–	4	Interview
7	Topic 2.4. Systems of differential equations. Brief content: state-space representation; systems of first-order differential equations; qualitative interpretation of solutions; engineering models of coupled dynamic processes and electrical systems.	ID-2 UC-1	–	2	–	4	Interview

8	Section 3. Complex Analysis. Topic 3.1. Complex numbers and functions. Brief content: algebraic, trigonometric and exponential forms of complex numbers; operations with complex numbers; complex functions; geometric interpretation on the complex plane.	ID-2 UC-1	–	2	–	4	Interview
9	Topic 3.2. Applications of complex analysis in electrical engineering. Brief content: phasor representation of sinusoidal quantities; complex impedance and admittance; calculation of AC circuits; interpretation of amplitude, phase shift and frequency-domain models.	ID-2 UC-1	–	2	–	4	Interview
10	Section 4. Fourier Analysis and Signal Processing. Topic 4.1. Fourier series and Fourier transform. Brief content: periodic signals and Fourier series; amplitude and phase spectra; Fourier transform; spectral representation of engineering signals and interpretation of frequency components.	ID-2 UC-1	–	2	–	4	Interview
11	Topic 4.2. Discrete Fourier transform and FFT. Brief content: sampled signals; discrete Fourier transform; fast Fourier transform algorithm; spectral leakage and sampling effects; implementation of signal analysis in MATLAB or Python.	ID-2 UC-1	–	2	–	4	Interview
12	Section 5. Numerical Methods. Topic 5.1. Numerical solution of linear systems and integration. Brief content: iterative and direct methods for linear systems; numerical integration rules; error estimation; computational implementation for engineering calculations.	ID-2 UC-1	–	2	–	4	Interview
13	Topic 5.2. Numerical solution of differential equations. Brief content: Euler method, improved Euler method and Runge–Kutta methods; stability and accuracy of numerical schemes; simulation of transient engineering processes.	ID-2 UC-1	–	2	–	6	Interview
14	Section 6. Optimization. Topic 6.1. Unconstrained optimization. Gradient methods. Brief content: objective functions; local and global extrema; gradient descent; convergence issues; optimization examples in engineering design and parameter selection.	ID-2 UC-1	–	2	–	6	Interview
15	Topic 6.2. Constrained optimization and Lagrange multipliers. Brief content: equality and inequality constraints; Lagrange multiplier method; interpretation of constraints in engineering problems; optimization under technical and operational limitations.	ID-2 UC-1	–	4	–	6	Interview
16	Section 7. Probability Theory and Statistics. Topic 7.1. Probability distributions. Statistical estimation and regression analysis. Brief content: random variables and probability distributions; mathematical expectation and variance; statistical estimation; confidence intervals; regression analysis for engineering data.	ID-2 UC-1	–	4	–	6	Interview
	TOTAL		–	36	–	72	

6. Assessment tools for ongoing progress control and intermediate assessment of students in the discipline (module)

The assessment tools (AT) for ongoing progress control and intermediate assessment of students in the discipline " Engineering Mathematics " are based on the list of competencies to be acquired, indicating the stages of their formation during the study of the discipline (module). The AT ensures objective monitoring of the achievement of the planned learning outcomes. The AT includes:

- a description of indicators and criteria for assessing competencies at various stages of their formation, and a description of grading scales;
- methodological materials defining the procedures for assessing knowledge, skills, abilities, and/or experience of activities that characterize the stages of competency formation;
- standard control tasks and other materials necessary for assessing knowledge, skills, and the level of mastery of the competencies being formed during the study of the discipline (module).

The assessment tools are 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 organized thematically; each topic represents a logically complete section.

Practical classes are conducted to consolidate the acquired information and develop skills in applying it to solve practical problems in the relevant subject area.

Students' independent work is aimed at independently studying additional material, preparing for practical, as well as completing all types of independent work.

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

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 basic literature:

1. Katalazhnova, I. N. Linear Algebra: A Teaching Guide / I. N. Katalazhnova. — Komsomolsk-on-Amur: Komsomolsk-on-Amur State University, 2024. — 65 p. — ISBN 978-5-7765-1575-0. — Text: electronic // IPR SMART Digital Educational Resource: [website]. — URL: <https://www.iprbookshop.ru/140649.html>
2. Advanced Mathematics. Volume 4. Differential Equations. Series. Fourier Series and the Fourier Transform. Differential and Integral Calculus of Functions of Several Variables. Field Theory: Textbook / A. P. Gospodarikov, M. A. Zatsepin, G. A. Kolton [et al.]; edited by A. P. Gospodarikov. — Saint Petersburg: National University of Mineral Resources "Gorny," 2015. — 213 p. — ISBN 978-5-94211-713-9. — Text: electronic // IPR SMART Digital Educational Resource: [website]. — URL: <https://www.iprbookshop.ru/71690.html>
3. Gilmudinov, R. F. Numerical Methods: A Textbook / R. F. Gilmudinov, K. R. Khabibullina. — Kazan: Kazan National Research Technological University, 2018. — 92 p. — ISBN 978-5-7882-2427-5. — Text: electronic // IPR SMART Digital Educational Resource: [website]. — URL: <https://www.iprbookshop.ru/95068.html>

8.1.2. List of additional literature:

1. Novikov, A. I. Discrete Fourier Transform and Image Processing: A Textbook / A. I. Novikov. — Ryazan: Ryazan State University of Radio Engineering, 2022. — 92 p. — Text: electronic // IPR SMART Digital Educational Resource: [website]. — URL: <https://www.iprbookshop.ru/137316.html>
2. Ivanova, V. E. Digital Signal Processing and Signal Processors: A Textbook / V. E. Ivanova, A. I. Tyazhev; edited by A. I. Tyazhev. — 2nd ed. — Samara: Volga State University of Telecommunications and Informatics, 2017. — 253 p. — Text: electronic // IPR SMART Digital

Educational Resource: [website]. — URL: <https://www.iprbookshop.ru/75425.html>

3. Yakovlev, V. P. Probability Theory and Mathematical Statistics: A Textbook for Undergraduates / V. P. Yakovlev. — 4th ed. — Moscow: Dashkov and K, 2018. — 182 p. — ISBN 978-5-394-03001-7. — Text: electronic // IPR SMART Digital Educational Resource: [website]. — URL: <https://www.iprbookshop.ru/85458.html>

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

1. Methodological Guidelines for Practical Classes in the Discipline "Engineering Mathematics" for Students in the Field of Study 13.04.02 Electric Power Engineering and Electrical Engineering. – North Caucasus Federal University, 2026.

2. Methodological Recommendations for Organizing Independent Work of Students in Preparation for Classes in the Fields of Study: 13.04.02 Electric Power Engineering and Electrical Engineering. – North Caucasus Federal University, 2026.

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

1. <http://biblioclub.ru> – Electronic Library System "University Library Online"
2. <http://catalog.ncstu.ru> – Electronic Catalog of the Association of Electronic Libraries of Educational Institutions and Organizations of the North Caucasus Federal District
3. <http://www.iprbookshop.ru> – Electronic Library System
4. <http://window.edu.ru/> – Unified Window of Access to Educational Resources
5. <http://openedu.ru> – National Online Learning Portal "Open Education"

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

In seminar and practical classes, students present presentations prepared by them during independent study hours.

Information reference systems:

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

1	ConsultantPlus – http://www.consultant.ru/
2	https://minenergo.gov.ru/ – Official website of the Ministry of Energy of Russia

Software:

1	Alt Workstation 10
2	Alt Workstation K
3	Alt Server
4	Office suite – R7-Office

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

Practical classes	Classroom for conducting training sessions, equipped with multimedia equipment and technical teaching aids.
Independent work	A room for independent work of students, equipped with computer equipment with the ability to connect to the Internet and access to the university's electronic information and educational environment.

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 means of learning for collective and individual use, services of an assistant who provides students with the necessary technical assistance, as well as sign language interpreting and typhlo-sign language interpreting services.

Mastering the discipline (module) by students with disabilities may be organized together with other students, as well as in separate groups.

Mastering of the 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 persons with disabilities when mastering the discipline (module), the following is provided:

1) For persons with visual disabilities:

- presence of an assistant who provides the student with the necessary technical assistance taking into account individual characteristics (helps to take a seat, move around, read and complete the task, including writing under dictation);
- written assignments, as well as instructions on the procedure for their completion, are formatted in enlarged font;
- special textbooks, teaching aids and didactic materials (with large print or audio files);
- individual uniform lighting of at least 300 lux;
- if necessary, a magnifying device is provided to the student for completing the task.

2) For persons with hearing disabilities:

- presence of an assistant who provides the student with the necessary technical assistance taking into account individual characteristics (helps to take a seat, move around, read and complete the task, including writing under dictation);
- provision of collective sound amplification equipment; if necessary, the student is provided with individual sound amplification equipment;
- provision of appropriate sound means of information reproduction.

3) For persons with musculoskeletal disorders (including those with severe motor impairments of the upper limbs or absence of upper limbs):

- written assignments are performed on a computer with specialized software or dictated to an assistant;
- at the student's request, assignments may be completed orally.

12. Features of implementing the discipline using distance educational 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 understood as the organization of educational activities using information contained in databases and used in the implementation of educational programs, information technologies and technical means that ensure its processing, as well as information and telecommunications networks that ensure the transmission of said information through communication lines and the interaction of students and teaching staff. Distance educational technologies are understood as educational technologies implemented primarily using

information and telecommunications networks with indirect (remote) interaction between students and teaching staff.

The discipline may be implemented using distance educational technologies and e-learning in whole or in part. The components of the educational and methodological set of the discipline (syllabus, assessment and methodological materials, forms of certification) implemented using distance educational technologies and e-learning contain an indication of their use.

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

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

When organizing intermediate assessment using distance educational technologies and e-learning, the Methodological Recommendations on the use of technical means ensuring the objectivity of results during intermediate and state final assessment in higher education programs – bachelor's programs, specialist's programs and master's programs using distance educational technologies (Letter of the Ministry of Science and Higher Education of the Russian Federation dated December 7, 2020 No. MN-19/1573-AN "On sending methodological recommendations") are applied.

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

The educational and methodological support of the discipline implemented using e-learning and distance educational technologies includes the syllabus, educational and methodological manuals or a lecture course, methodological guidelines for performing various types of learning activities provided for by the discipline, and other educational and methodological materials posted in the electronic information and educational environment of NCFU, all presented in electronic form.