

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

Methodological guidelines
for independent work in the discipline
«Theory of Electrical Networks»
for students of the field of study 13.04.02 Electric Power Engineering and
Electrical Engineering

Stavropol 2026

INTRODUCTION

Independent work of students is a mandatory component of the educational process for each student and is determined by the curriculum. The types of independent work of students are determined by the content of the academic discipline when developing syllabi and educational and methodological packages. When determining the content of students' independent work, one should take into account their level of independence and the requirements for the level of independence of graduates so that the desired level is achieved during the period of study. Thus, the share of independent work in full-time study is up to 50% of the number of classroom hours allocated for studying the discipline; in distance learning, the number of hours allocated for mastering the discipline increases to 90%.

Independent work is defined as individual or collective learning activities carried out without the direct guidance of a teacher, but according to the teacher's assignments and under their supervision.

Independent work is a cognitive educational activity in which the sequence of the student's thinking, their mental and practical operations and actions depends on and is determined by the student themselves. Students' independent work contributes to the development of independence, responsibility, organization, and a creative approach to solving problems at the educational and professional level, which ultimately leads to the development of the skill of independent planning and implementation of activities.

The goal of students' independent work is to master the necessary competencies in their field of study, as well as the experience of creative and research activity.

Based on the competency-based approach to the implementation of professional educational programs, the types of assignments for independent work are:

- **For mastering knowledge:** reading text (textbook, primary source, additional literature), outlining the text, graphical representation of the text structure, making notes, extracting key points from the text, working with dictionaries and reference books, familiarization with regulatory documents, educational research work, using audio and video recordings, computer technology and the Internet information and telecommunications network, etc.
- **For consolidating and systematizing knowledge:** working with lecture notes, processing text (textbook, primary source, additional literature, audio and video recordings), reworking educational material, drawing up an outline, creating tables to systematize educational material, answering test questions, filling out a workbook, analytical text processing (annotation, reviewing, abstracting, summary analysis, etc.), completing classroom practical work and preparing reports on them, preparing multimedia messages/reports for presentations at seminars (conferences), presentation materials, preparing an abstract, compiling a bibliography, thematic crosswords, testing, etc.
- **For developing skills:** solving problems and exercises by example, solving variable problems, performing drawings, diagrams, performing calculations (graphical works), solving situational (professional) problems, preparing for business games, designing and modeling various types and components of professional activity, reflective analysis of professional skills using audio and video equipment, etc.

Independent work can be carried out individually or by groups of students, depending on the goal, volume, specific topic of independent work, level of complexity, and level of student skills.

Monitoring the results of students' independent work can be carried out within the time allocated for compulsory classes in the discipline and for extracurricular independent work in the discipline; it can be conducted in written, oral, or mixed form.

Independent work is carried out in the form of exercises when studying new material, exercises during consolidation and review, exercises for tests and examinations, as well as for self-monitoring.

The following conditions are necessary for organizing independent work:

1. Students' readiness for independent work;
2. The availability and accessibility of necessary educational, methodological, and reference materials;
3. Advisory assistance.

Independent work can take place in a lecture hall, computer lab, library, or at home. Independent work contributes to the formation of competencies, trains the will, fosters efficiency, attention, discipline, and responsibility.

1 General characteristics of independent work of a student when studying the discipline

Within the framework of the discipline course, students' independent work is actively applied and includes various types of activities:

- preparation for practical classes, including work with methodological guidelines and mass media;
- preparation for lectures, including independent in-depth study of the theoretical course using recommended literature;
- preparation for intermediate assessment.

The goal of a student's independent work when preparing for lectures is to acquire new knowledge gained through a deeper study of the discipline literature.

Objectives:

- finalizing and reviewing lecture notes;
- understanding the content of the lecture, its logical structure, and conclusions.

The goal of a student's independent work when preparing for practical classes is to deepen, expand, and detail the knowledge obtained in a generalized form during lectures.

Objectives:

- develop the ability to apply the acquired knowledge in practice when solving specific tasks;
- test the knowledge acquired by students during lectures and independent study of literature.

2 Content of the discipline (module)

№	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	Topic 1. DC Circuits. Basic Concepts. Introduction. Systems of Units. Charge and Current. Voltage. Power and Energy.			2		2	Interview
2	Topic 2. DC Circuits. Circuit Elements. Applications. The Steps of Problem Solving.			2		2	Interview
3	Topic 3. DC Circuits. Basic Laws. Ohm’s Law. The resistance. A short circuit. An open circuit. Conductance.			2		2	Interview
4	Topic 4. DC Circuits. Basic Laws. Nodes, Branches, and Loops. The series and parallel connection.			2		2	Interview
5	Topic 5. DC Circuits. Basic Laws. Kirchhoff’s Laws. Kirchhoff’s current law. Kirchhoff’s voltage law.			2		2	Interview
6	Topic 6. DC Circuits. Basic Laws. Series Resistors and Voltage Division. The equivalent resistance. Parallel Resistors and Current Division.			2		2	Interview
7	Topic 7. DC Circuits. Basic Laws. Wye-Delta Transformations. Delta to Wye Conversion. Wye to Delta Conversion.			1		2	Interview
8	Topic 8. DC Circuits. Basic Laws. Applications. Lighting Systems. Design of DC Meters.			1		2	Interview

9	Topic 9. DC Circuits. Methods of Analysis. Nodal Analysis. Steps to Determine Node Voltages. Current flows.			1		2	Interview
10	Topic 10. DC Circuits. Methods of Analysis. Nodal Analysis with Voltage Sources. A supernode.			1		2	Interview
11	Topic 11. DC Circuits. Methods of Analysis. Mesh Analysis. Steps to Determine Mesh Currents.			1		2	Interview
12	Topic 12. DC Circuits. Methods of Analysis. Mesh Analysis with Current Sources. A supermesh.			1		2	Interview
13	Topic 13. DC Circuits. Methods of Analysis. Nodal and Mesh Analyses by Inspection. The conductance matrix. The resistance matrix			1		2	Interview
14	Topic 14. DC Circuits. Methods of Analysis. Nodal Versus Mesh Analysis. A computer software package.			1		2	Interview
15	Topic 15. DC Circuits. Methods of Analysis. Applications: DC Transistor Circuits. Bipolar junction transistors (BJTs) and field-effect transistors (FETs). The common-base current gain. The common-emitter current gain			1		2	Interview
16	Topic 16. DC Circuits. Circuit Theorems. Linearity Property. The homogeneity property. The additivity property. A linear circuit.			1		2	Interview
17	Topic 17. DC Circuits. Circuit Theorems. Superposition. Steps to Apply Superposition Principle. Source Transformation.			1		2	Interview
18	Topic 18. DC Circuits. Circuit Theorems. Thevenin's Theorem. Norton's Theorem. Derivations of Thevenin's and Norton's Theorems.			1		2	Interview
19	Topic 19. DC Circuits. Circuit Theorems. Maximum Power Transfer.			1		2	Interview

20	Topic 20. DC Circuits. Circuit Theorems. Applications. Source Modeling. Resistance Measurement.			1		2	Interview
21	Topic 21. DC Circuits. Capacitors and Inductors. Capacitance. Factors determine the value of the capacitance. The important properties of a capacitor. Series and Parallel Capacitors. The equivalent capacitance.			1		2	Interview
22	Topic 22. DC Circuits. Capacitors and Inductors. Inductors. Inductance. A linear inductor and a nonlinear inductor. The important properties of an inductor. Series and Parallel Inductors.			1		2	Interview
23	Topic 23. DC Circuits. Capacitors and Inductors. Applications. Integrator. Differentiator. Analog Computer.			1		2	Interview
24	Topic 24. DC Circuits. First-Order Circuits. The Source-Free RC Circuit. The natural response. The time constant. The Key to Working with a Source-free RC Circuit.			1		2	Interview
25	Topic 25. DC Circuits. First-Order Circuits. The Source-Free RL Circuit. The Key to Working with a Source-free RL Circuit.			1		2	Interview
26	Topic 26. DC Circuits. First-Order Circuits. Singularity Functions. Switching functions. The unit step function. The unit impulse function. The unit ramp function.			1		2	Interview
27	Topic 27. DC Circuits. First-Order Circuits. Step Response of an RC Circuit. The complete response. The natural response. The forced response. The transient response. The steady-state response. the step response of an RC circuit.			1		2	Interview
28	Topic 28. DC Circuits. First-Order Circuits. Step Response of an RL Circuit. The step response of an RL circuit.			1		2	Interview

29	Topic 29. DC Circuits. First-Order Circuits. Applications. Delay Circuits. Photoflash Unit. Relay Circuits. Automobile Ignition Circuit.			1		2	Interview
30	Topic 30. DC Circuits. Second-Order Circuits. Finding Initial and Final Values. The capacitor voltage. The inductor current.			1		2	Interview
31	Topic 31. DC Circuits. Second-Order Circuits. The Source-Free Series RLC Circuit. A second-order differential equation. The characteristic equation. Natural frequencies. the Resonant frequency. Undamped natural frequency. The neper frequency.			1		2	Interview
32	Topic 32. DC Circuits. Second-Order Circuits. The overdamped case. The critically damped case. The underdamped case. Peculiar properties of an RLC network			1		2	Interview
33	Topic 33. DC Circuits. Second-Order Circuits. The Source-Free Parallel RLC Circuit. The overdamped case. The critically damped case. The underdamped case.			1		2	Interview
34	Topic 34. DC Circuits. . Second-Order Circuits. Step Response of a Series RLC Circuit. The overdamped case. The critically damped case. The underdamped case.			1		2	Interview
35	Topic 35. DC Circuits. Second-Order Circuits. Step Response of a Parallel RLC Circuit. The overdamped case. The critically damped case. The underdamped case.			1		2	Interview
36	Topic 36. DC Circuits. Second-Order Circuits. General Second-Order Circuits. The step response by taking the four steps. Duality.			1		2	Interview

37	Topic 37. DC Circuits. Second-Order Circuits. Applications. Automobile Ignition System. The breaking points or electronic ignition. Smoothing Circuits.			1		2	Interview
38	Topic 38. AC Circuits. Sinusoids and Phasors. A sinusoidal current. The sinusoidal steady-state response. The amplitude. The angular frequency. The argument. The period. A periodic function. A graphical approach.			1		2	Interview
39	Topic 39. AC Circuits. Sinusoids and Phasors. A phasor. Rectangular form. Polar form. Exponential form. The relationship between the rectangular form and the polar form. The operation by complex numbers. The phasor representation. A phasor diagram. Sinusoid-phasor transformation. The frequency domain			1		2	Interview
40	Topic 40. AC Circuits. Sinusoids and Phasors. Phasor Relationships for Circuit Elements. Voltage-current relations for a resistor in the: time domain, frequency domain. Voltage-current relations for an inductor in the: time domain, frequency domain. Voltage-current relations for a capacitor in the: time domain, frequency domain.			1		2	Interview
41	Topic 41. AC Circuits. Sinusoids and Phasors. Impedance and Admittance. Kirchhoff's Laws in the Frequency Domain. Impedance Combinations. The balanced wye circuit.			1		2	Interview
42	Topic 42. AC Circuits. Sinusoidal Steady-State Analysis. Steps to Analyze AC Circuits. Nodal Analysis. Mesh Analysis.			1		2	Interview
43	Topic 43. AC Circuits. Sinusoidal Steady-State Analysis. Superposition Theorem. Source Transformation. Thevenin and Norton Equivalent Circuits.			1		1	Interview

44	Topic 44. AC Circuits. Sinusoidal Steady-State Analysis. Applications. Capacitance Multiplier. Oscillators.			1		1	Interview
45	Topic 45. AC Circuits. AC Power Analysis. Instantaneous and Average Power. A resistive load (R) absorbs power at all times, while a reactive load (L or C) absorbs zero average power.			1		1	Interview
46	Topic 46. AC Circuits. AC Power Analysis. Maximum Average Power Transfer. For maximum average power transfer, the load impedance ZL must be equal to the complex conjugate of the Thevenin impedance ZTh.			1		1	Interview
47	Topic 47. AC Circuits. AC Power Analysis. Effective or RMS Value. Apparent Power and Power Factor. The power factor angle.			1		1	Interview
48	Topic 48. AC Circuits. AC Power Analysis. Complex Power. The power triangle. The impedance triangle. Conservation of AC Power. Power Factor Correction.			1		1	Interview
	TOTAL			54		90	

3 Methodological recommendations for studying theoretical material

Independent work of a student during lecture classes includes studying theoretical questions assigned for independent study in accordance with the syllabus, working through lecture materials to prepare for knowledge control in lecture classes (questioning), and preparing questions for discussion during consultations with the teacher.

Work with lecture material does not end with the lecture. For every 2 hours of lecture, about one hour should be spent working with the notes. During this time, it is necessary to re-read the notes, supplement them with information that was remembered from the teacher's speech but could not be written down. While working with the notes, one should note unclear questions to be clarified with the teacher during consultation. Questions related to the lecture topic that the teacher assigned for independent study should be highlighted separately.

A lecture summary actively worked on during the semester will later serve as the basis for preparing for the exam.

Questions for independent study are presented in section 5.

Independent work during practical classes includes completing assignments for practical classes, in particular solving problems of varying difficulty levels. The problems are provided in the methodological guidelines for practical classes and in the assessment tools.

Knowing the topic of the practical class, one should prepare for it in advance. For effective preparation for a practical class, it is necessary to have a methodological guide for the practical class.

The criteria for assessing practical classes are presented in the assessment tools.

When checking a practical assignment, the following are assessed: the sequence and rationality of presenting the material; completeness and sufficiency of the answer; scientific rigor in handling basic concepts; use and study of additional literary sources.

The criteria for assessing the results of independent work: questions for interviews and exams are given in the assessment tools for the discipline.

4 Methodological recommendations for organizing independent work of students

Independent work is one of the types of learning activities of students; it contributes to the development of independence, responsibility, organization, and a creative approach to solving problems at the educational and professional level.

In-class independent work in the discipline is carried out in training sessions under the direct guidance of the teacher and according to the teacher's assignment.

Out-of-class independent work is performed according to the teacher's assignment without the teacher's direct participation.

The types of assignments for out-of-class independent work, their content, and nature can be variable and differentiated, taking into account the specifics of the discipline being studied and the individual characteristics of the student.

Monitoring of independent work and evaluation of its results is organized as a unity of two forms:

1. Self-monitoring and self-assessment by the student;
2. Monitoring and assessment by the teacher.

5 Methodological recommendations for taking notes during lectures

During lecture classes, take notes of the educational material. Pay attention to categories, formulations that reveal the content of certain phenomena and processes, scientific conclusions and practical recommendations, and positive examples in oratory. It is advisable to leave margins in your working notes to make notations from recommended literature that supplement the material of the lecture, as well as to highlight the particular importance of certain theoretical provisions. Ask the teacher clarifying questions in order to understand theoretical provisions and resolve controversial issues.

When preparing for seminars, study the main literature, familiarize yourself with additional literature, new publications in periodicals: journals, newspapers, etc. Take into account the teacher's

recommendations and the requirements of the curriculum. Refine your lecture notes by making appropriate entries from the literature recommended by the teacher and provided for in the curriculum. Prepare theses for presentations on all educational issues to be discussed at the seminar. When preparing for a report or abstract presentation, seek methodological help from the teacher. Draft an outline of your presentation. Think of examples to ensure a close connection between the theory being studied and real life. Timely and high-quality completion of independent work is based on compliance with these recommendations and the study of recommended literature. The student may supplement the list of references used with modern sources not presented in the list of recommended literature and subsequently use their own prepared educational materials when writing papers.

6 Methodological recommendations for preparing for practical classes

A practical class is one of the most effective types of training sessions in which students learn to work creatively, argue and defend their position, and correctly and clearly express their thoughts to an audience. The main thing in preparing and conducting practical classes is the student's independent work on studying the topic. The student must know exactly the plan of the lesson or the specific assignment for it. Key issues of the topic are discussed in class, but there may also be issues that were not covered in the lecture. There may also be special assignments for a particular topic.

One should prepare for a practical class in advance. It is necessary to carefully review the plan and other materials, understand the issues to be discussed. Then one needs to select literature and other necessary material, including recommended material (through the library, the department's educational and methodological office, etc.). But first of all, one should refer to one's lecture notes and the relevant section of the textbook. The study of all sources should be aimed at finding answers to the issues raised in the practice-oriented classes.

The final stage of preparation for classes consists of completing individual assignments.

Commented [AS1]: В случае, если по данной дисциплине проводятся только лекционные или практические занятия, необходимо удалить соответствующий раздел