

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION OF HIGHER
EDUCATION
"NORTH CAUCASUS FEDERAL UNIVERSITY"

Suggestions for Teaching

on the organization and conduct of independent work
by discipline

Circuit Analysis

for students of the field of study / specialty
11.03.02 Infocommunication Technologies and Communication Systems
Profile
"Intelligent Data Processing in Infocommunication
Systems and Networks"

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Introduction

The purpose of students' independent work in the study of the discipline Circuit Analysis is to obtain knowledge on the theory of various electrical circuits to solve the problems of transmission, processing and distribution of electrical signals in communication systems. The task of students' independent work in the discipline "Theory of Electrical and Radio Engineering Circuits":

- mastering modern methods of analysis, synthesis and calculation of electrical and radio circuits, as well as methods of modeling and studying various modes of electrical circuits on personal computers.

As a result of mastering the discipline, students must:

Know:

- Fundamentals of theory, methods and means of theoretical and experimental study of linear and nonlinear electrical and radio engineering circuits under harmonic and non-harmonic influences;
- the basics of the four-pole theory;
- Fundamentals of the theory of stability of electrical circuits with feedback;
- Fundamentals of the theory of electrical analog, discrete and digital filters.

Be able to:

- calculate the parameters and characteristics of linear and nonlinear electrical circuits;
- calculate and analyze the parameters of electrical circuits and filters on personal computers;
- carry out computer modeling of electrical circuits and processes in them using universal packages of applied computer programs.

Own:

- skills of experimental study of electrical circuits within the framework of physical and mathematical modeling;
- the main methods, ways and means of obtaining, storing, processing information in the study of electrical circuits.

1. General characteristics of the student's independent work in the study of the discipline Circuit Analysis

Codes of	Type of student	Final product of	Assessment	Number of hours, including
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implemented competencies, indicator(s)	activity	independent work	Tools and Technologies	SRS	Contact work with the teacher	Total
Semester 6						
OPK-1 ID-1OPK-1 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-3OPK-2 ID-4OPK-2 ID-5OPK-2	Computer modeling with the use of graphic editors	Practical Work Reports	Test task (checkpoint), performing individual (group) tasks from laboratory work	56	28	84.00
OPK-1 ID-1OPK-1 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-3OPK-2 ID-4OPK-2 ID-5OPK-2	Independent study of literature	Synopsis	Interview, Evaluation of answers to the questions of the given topics	10	2	12.00
OPK-1 ID-1OPK-1 ID-2 _{OPK-1} ID-3 _{OPK-1} OPK-2 ID-3OPK-2 ID-4OPK-2 ID-5OPK-2	Self-testing, preparation for testing	Results of control computer testing	Testing with the help of computer test tasks	10	2	12.00
Total for the semester				76.00	32.00	108.00
Total				76.00	32.00	108.00

2. Schedule for independent work

Control Point Name Semester 4	Completion date	Week number of the academic semester	Weight in points
Linear Electrical Circuits under Harmonic Influences		4	15

Frequency and Time Characteristics of Electrical Circuits		8	15
Characteristics of electrical signals		12	15
Electrical precipitators		15	10

4. Methodical recommendations for the study of theoretical material

Recommendations for the organization of work in the independent study of lecture topics and preparation for laboratory work

Students are recommended to:

- on the day of the lesson, work out the educational material studied in the lesson according to the notes. At the same time, it is necessary to highlight the questions that should be paid more attention to in the further study of the current topic. After working through the educational material, it is necessary to answer the recommended control questions;

- In order to qualitatively consolidate the studied material in the future, it is necessary to work out the educational material in more detail using the recommended literature. Students are recommended to identify issues that require more detailed study with the help of a teacher;

- On the eve of the laboratory lesson, the student is recommended to consolidate the theoretical material that is brought to the lesson and understand its role in achieving the goals, prepare questions that require clarification from the teacher.

Recommendations for the organization of work with literature

To master, consolidate and systematize knowledge, students are recommended to work independently with the recommended literature and lecture notes. When working independently with the recommended literature, students are recommended to take notes of the educational material set forth in the recommended sources.

Taking notes of sources is carried out during a detailed study of the topic, while students are recommended:

- supplement the lecture notes by expanding it on the most important issues considered in the lesson. Taking notes of sources consists in supplementing the notes with the following provisions:

- basic definitions and their physical meaning;
- Basic physical principles of signal generation and processing in communication systems with graphic illustrations;
- basic mathematical relations with the disclosure of their physical meaning;
- conclusions on educational issues, the topic of the classes studied.

Control of this type of independent work is carried out in training sessions by checking the lecture notes and interviews by the teacher.

When taking notes of sources, students should proceed from the rational volume of the material being summarized. The synopsis should be concise and understandable when used after studying the current topic.

When taking notes of sources, it is recommended to highlight individual figures, their most important fragments, and most important formulas in color. When taking notes in class, it is recommended to fill in two-thirds of the page of the notebook sheet vertically, and use the free part when supplementing the notes on the issue under study.

For the successful development of the discipline, it is necessary to independently study the presented topics in detail according to the recommended sources of information:

No p/n	Self-study topics	Recommended sources of information (No source)			
		Main	Additional	Methodical	Internet Resources
1	Fundamentals of Theory and Methods of Analysis of Linear Electrical Circuits	1-2	1- 5	1-3	1, 4
2	Linear Electrical Circuits under Harmonic Influences	1-2	1- 5	1-3	4
3	Frequency Characteristics of Electrical Circuits	1-2	1- 5	1-3	2, 3
4	Linear Electrical Circuits under Non-Harmonic Effects	1-2	1- 5	1-3	3
5	Four-Pole and Distributed Circuits	1-2	1- 5	1-3	4
6	Closed-loop electrical circuits	1-2	1- 5	1-3	1, 4
7	Electrical precipitators	1-2	1- 5	1-3	3
8	Nonlinear Electrical Circuits	1-2	1- 5	1-3	1

Synopsis of sources is assessed as satisfactory and unsatisfactory. Work on synopsis of sources is evaluated as satisfactory if:

- the synopsis has a sufficient amount of detail on the topic being studied, providing a given level of mastery of the theoretical material of the discipline;
- the synopsis is neatly drawn up, the studied material is presented sequentially in accordance with the order of study of the discipline, contains generalizing conclusions on each topic.

Work on taking notes of sources is assessed unsatisfactorily if the requirements for a satisfactory assessment are not met.

5. Guidelines for laboratory work

When performing a workshop in the discipline (laboratory work), in order to achieve a basic level of competence formation, the student must be able to apply the knowledge gained in practice through solving problems of assessing and calculating the characteristics and parameters of analog and digital devices.

Possess the techniques and skills of solving problems of evaluating and calculating the characteristics of analog and digital devices.

When performing a workshop on the discipline (laboratory work), in order to achieve an advanced level of competence formation, the student must show a high ability to confidently apply the knowledge gained in practice through solving problems of assessing and calculating the characteristics and parameters of analog and digital devices.

5.1. Methodical instructions for preparing for laboratory work

Preparation for laboratory work is recommended to be carried out in the following sequence:

- to understand the topic and purpose of the upcoming laboratory work;
- study theoretical material in accordance with the topic of laboratory work (it is recommended to use recommended literature, lecture notes, textbook (workshop on laboratory work));
- get acquainted with the equipment and materials used in laboratory work (when using specialized equipment, it is necessary to study the procedure and rules for its use).

5.2. Methodical instructions for performing laboratory work

When performing laboratory work, students must strictly observe the established rules of labor protection.

When performing laboratory work, students are recommended:

- to understand the purpose of the tasks performed and ways to solve them;
- perform the tasks specified in the laboratory work in the sequence in which they are indicated in the laboratory practice;
- draw up a report on laboratory work;
- answer control questions.

5.3. Guidelines for preparing for the defense of laboratory work

When preparing for the defense of laboratory work, students are recommended:

- Prepare a report on laboratory work;
- prepare a justification for the conclusions made;
- consolidate knowledge of theoretical material on the topic of laboratory work (it is

recommended to use control questions);

- know the procedure for making calculations (conducting research);
- be able to show and explain the procedure for research when using specialized equipment.

The defense of the laboratory work is carried out by interviewing the student with the teacher. During the interview, the student submits a report on the laboratory work for verification. The interview with a student applying for an "excellent" grade is conducted on the issues of an advanced level of study. An interview with a student who does not apply for an "excellent" grade is conducted on the issues of the basic level of study.

6. Questions for the exam

Basic level

Questions to check the level of learning:

1. Ohm's law for an inhomogeneous section of an electrical circuit.
2. Equivalent Passive Chain Conversions.
3. Kirchhoff's laws. Kirchhoff's method of equations.
4. Superposition method in the analysis of DC electrical circuits.
5. The Equivalent Voltage Generator Method in the Analysis of DC Electrical Circuits.
6. The Equivalent Current Generator Method in the Analysis of DC Electrical Circuits.
7. Method of contour currents.
8. The method of nodal potentials for calculating currents in the branches of a DC electric circuit.
9. The two-node method in the analysis of an electrical circuit.
10. Power balance in a DC electrical circuit.
11. Conditions for transferring maximum power to the load.
12. A graphical representation of harmonic (sinusoidal) current.
13. Values characterizing sinusoidal current.
14. Vector form of representation of harmonic (sinusoidal) current.
15. Symbolic (complex) form of representation of harmonic (sinusoidal) current.
16. An ideal resistive element in a harmonic current circuit.
17. An ideal capacitive element in a harmonic current circuit.
18. Ideal inductive element in a harmonic current circuit
19. Power balance in a sine current electrical circuit.
20. Complex resistances. Resistance triangle.
21. Resonance of currents in an electric circuit. Triangle of currents.
22. Resonance of voltages in an electrical circuit.

23. Types of power in electrical circuits and their balance. Power triangle.
24. Matching the harmonic current electrical power source to the load.
25. Three-phase circuit. Star connection
26. Three-phase circuit. Triangle connection
27. Complex transmission function of the electrical circuit
28. Frequency characteristics of the LF-1.
29. Frequency characteristics of the VCh-1.
30. Frequency characteristics of the bandwidth.
31. Parameters and frequency characteristics of a series oscillating circuit
32. Parameters and Frequency Characteristics of a Parallel Oscillating Circuit
33. Laws of switching in electrical circuits.
34. Analysis of transients in the RC circuit using the classical method.
35. Analysis of transient processes in the RL circuit by the classical method.
36. The Laplace transform and its basic properties.
37. Operator schemes for replacing electrical circuit elements under zero initial conditions.
38. Ohm's law in operator form.
39. Analysis of transient processes in the RC circuit by the operator method.
40. Analysis of transient processes in the RL circuit by the operator method.
41. Operator transfer functions of the LF-1.
42. Operator transfer functions of the VCh-1.
43. Operator transfer functions of the strip link.
44. Timing characteristics of electrical circuits.
45. Spectral representation of periodic signals.
46. Spectra of the periodic sequence of square pulses.
47. Spectral representation of aperiodic signals.
48. Primary parameters of four-poles. Systems of equations of four-poles.
49. Primary parameters of four-poles. Physical meaning of A-parameters.
50. Primary parameters of composite four-poles.
51. Secondary (characteristic) parameters of four-poles. Characteristic resistances of a four-pole.
52. Secondary (characteristic) parameters of four-poles. Four-pole transmission constant.
53. Primary parameters of a uniform long line.
54. Secondary (characteristic) parameters of a homogeneous long line under harmonic action.
55. Wave modes in a uniform long line under harmonic action. Traveling wave mode.
56. Wave modes in a homogeneous long line under harmonic action. Standing wave regime.
57. Types of feedbacks and their influence on the parameters of active four-poles.

58. Mikhailov's stability criterion.
59. Hurwitz stability criterion.
60. Types of electric precipitators and conditions of their physical realization.
61. Problems and methods of approximation of frequency characteristics of electric filters.
62. Filtration conditions for ladder filters.
63. Frequency characteristics of LPF type "k".
64. Frequency characteristics of HPF type "k".
65. Problems of the synthesis of electric filters.
66. Approximation of the frequency characteristics of the LPF prototype.
67. Synthesis of electrical passive filters by tabular method.
68. Synthesis of Electrical Passive Filters by Analytical Method.
69. Synthesis of active filters by substitution method.
70. Diagram and frequency response of an active first-order RC low-pass filter.
71. Diagram and frequency response of an active first-order RC high-pass filter.
72. Principles of digital filtering.
73. Forms of representation of discrete signals.
74. Discrete Fourier transform.
75. System function of digital filters.
76. Difference equations of discrete circuits.
77. Discrete filters with finite impulse response.
78. Nonlinear elements of electrical circuits and their characteristics.
79. Methods for the analysis of nonlinear DC electrical circuits.

Tasks to test skills and abilities

1. Calculate currents and voltages in a given DC circuit using the transformation method.
2. Calculate currents and voltages in a given DC circuit using the Kirchhoff equation method.
3. Calculate the currents and voltages in a given DC circuit using the superposition method.
4. Calculate the currents and voltages in a given DC circuit using the equivalent current generator method.
5. Calculate the currents and voltages in a given DC circuit using the equivalent voltage generator method.

6. Calculate currents and voltages in a given DC circuit using the contour current method.
7. Calculate currents and voltages in a given DC circuit using the nodal potential method
8. Calculate and plot the frequency characteristics of first-order links.
9. Calculate and plot the frequency characteristics of a sequential oscillating circuit.
10. Calculate and plot the frequency characteristics of a parallel oscillating circuit.
11. Calculate and build graphs of the time characteristics of the first-order links
12. Analysis of transients in the RC circuit using the classical method.
13. Analysis of transient processes in the RL circuit by the classical method.
14. Analysis of transient processes in the RC circuit by the operator method.
15. Analysis of transient processes in the RL circuit by the operator method.
16. Determine the spectral characteristics of an aperiodic signal.
17. Calculate the primary parameters of a given four-pole.
18. Calculate and plot the frequency response of an LC filter.
19. Calculate and plot the frequency response of an ARC filter.
20. Calculate and plot the frequency response of a discrete FIR filter.

Increased level

Questions to check the level of learning:

1. Generalized Ohm's law.
2. Equivalent active chain conversions.
3. The method of superposition in the analysis of electrical circuits of sinusoidal current.
4. The Equivalent Voltage Generator Method in the Analysis of Sine Current Electrical Circuits.
5. The method of an equivalent current generator in the analysis of electrical circuits of sinusoidal current.
6. Method of contour currents.
7. The method of nodal potentials for calculating currents in the branches of an electric circuit of sinusoidal current.
8. The two-node method in the analysis of a sinusoidal current electrical circuit.
9. Values characterizing sinusoidal current.
10. Symbolic (complex) form of representation of harmonic (sinusoidal) current.
11. Types of power in electrical circuits and their balance. Power triangle.

12. Matching the harmonic current electrical power source to the load.
13. Three-phase circuit. Star connection
14. Three-phase circuit. Triangle connection
15. Complex transmission function of the electrical circuit
16. Frequency characteristics of the LF-2.
17. Frequency characteristics of the HF-2.
18. Frequency characteristics of the bandwidth.
19. Coupled oscillating circuits. Substitution schemes.
20. Frequency Response of a Coupled Oscillating Circuit
21. Analysis of transient processes in the RLC circuit by the classical method.
22. Operator schemes for replacing elements of an electric circuit under non-zero initial conditions.
23. Analysis of transient processes in the RLC circuit by the operator method.
24. Operator transfer functions of the LF-2.
25. Operator transfer functions of the VCh-2
26. Operator transfer functions of the strip link.
27. Timing characteristics of electrical circuits.
28. *Impulse characteristic of the LF-2.*
29. *Transient characteristic of the LF-2.*
30. *Impulse characteristic of the strip link.*
31. *Transient characteristic of the strip link.*
32. *Temporal method of transient analysis.*
33. *Spectral representation of periodic signals.*
34. *Spectra of the periodic sequence of square pulses.*
35. *Theorems on spectra.*
36. Primary parameters of four-poles. Physical meaning of H-parameters.
37. Primary parameters of four-poles. Physical meaning of Y-parameters.
38. Four-pole operating parameters. Four-pole insertion attenuation.
39. Operating parameters of four-poles. Working weakening of four-poles.
40. Relationship of primary and secondary parameters of symmetric four-poles.
41. Wave Modes in a Uniform Long Line under Harmonic Action. Mixed Wave Mode.
42. Problems of matching a homogeneous long line with a load.
43. Matching a homogeneous long line to the load using a quarter-wave transformer.
44. Matching a Homogeneous Long Line with a Load Using a Tatarinov Loop
45. Nyquist stability criterion.

46. Series-derived links of filters of the "m" type.
47. Parallel-derived links of "m" type filters.
48. Frequency characteristics of LPF type "m".
49. Frequency characteristics of HPF type "m".
50. Bridge filter filtering conditions.
51. Amplitude and phase correctors.
52. Diagram and frequency response of an active second-order RC low-pass filter.
53. Diagram and frequency response of an active second-order RC high-pass filter.
54. Diagram and frequency response of an active RC bandpass filter.
55. Diagram and frequency response of the notch active RC filter.
56. Discrete Laplace transform.
57. Z-transform and its basic properties.
58. Discrete filters with infinite impulse response.
59. Methods for the analysis of nonlinear AC electrical circuits.

Tasks to test skills and abilities

1. Calculate currents and voltages in a given sinusoidal current circuit using the transformation method.
2. Calculate currents and voltages in a given sinusoidal current circuit using the Kirchhoff equation method.
3. Calculate the currents and voltages in a given sinusoidal current circuit using the superposition method.
4. Calculate currents and voltages in a given sinusoidal current circuit using the equivalent current generator method.
5. Calculate the currents and voltages in a given sine current circuit using the equivalent voltage generator method.
6. Calculate currents and voltages in a given sinusoidal current circuit using the contour current method.
7. Calculate currents and voltages in a given sinusoidal current circuit using the nodal potential method
8. Calculate and plot graphs of frequency characteristics of second-order links.
9. Calculate and plot the frequency response of a coupled oscillating circuit.
10. Calculate and plot the time characteristics of second-order links
11. Analysis of transients in the RC circuit by the time method.
12. Analysis of transient processes in the RLC circuit by the classical method.

13. Analysis of transients in RC circuits by frequency method.
14. Analysis of transient processes in the RLC circuit by the operator method.
15. Determine the spectral characteristics of a periodic signal.
16. Calculate the primary parameters of a given four-pole.
17. Calculate and plot the frequency response of an LC filter of type "m".
18. Calculate and plot the frequency response of a second-order ARC filter.
19. Calculate and plot the frequency response of a discrete FIR filter.
20. Calculate and plot the frequency response of a discrete filter with IIR.

Interview evaluation criteria:

The grade "excellent" is given to the student if the student gave a complete, detailed answer to the question, while showing the totality of conscious knowledge on the topic of the discipline, the main provisions of the question are demonstratively disclosed; the answer traces a clear structure, a logical sequence reflecting the essence of the concepts disclosed. The answer is presented in literary language using technical terminology.

The grade "good" is given to the student if the student gave a complete, detailed answer to the question, while the ability to distinguish essential and insignificant features, cause-and-effect relationships is shown. The answer is clearly structured, logical, presented in literary language using technical terminology. 2-3 inaccuracies or minor mistakes may be made, corrected by the student with the help of the teacher.

The grade "satisfactory" is given to the student if the student gave an incomplete and insufficiently detailed answer. The logic and sequence of presentation have violations. Mistakes were made in the disclosure of concepts, the use of terms. The student is not able to independently distinguish essential and insignificant features and cause-and-effect relationships. There are no conclusions in the answer. The ability to reveal the meaning of generalized knowledge is not shown. Speech design requires corrections, correction.

The grade "unsatisfactory" is given to the student if the answer is disparate knowledge with significant errors on the question. There is fragmentarity, illogic of presentation. The student is not aware of the connection of the discussed issue with other questions of the topic. There are no conclusions, concretization and evidence of the presentation. The speech is illiterate, terminology is not used. Additional and clarifying questions of the teacher do not lead to the correction of the student's answer, or the answer to the question is completely absent or the student refused to answer. The situational task on the topic is solved incorrectly.

7. Educational, methodological and information support of the discipline

7.1. List of basic and additional literature necessary for mastering the discipline (module)

7.1.1. List of basic literature:

1. Ivanov M.T., Sergienko A., Ushakov V. Radiotechnical Circuits and Signals: Textbook. - St. Petersburg: Piter, 2014. - 334 p.; 24. - (Textbook for Higher Educational Institutions. Standard of the Third Generation). - Vulture: Rek. UMO. - References: p. 320. - Alf. Decree: p. 321-334. - ISBN 978-5-496-00503-6 – 15 copies.
2. Kaganov V.I. Radiotechnical Circuits and Signals: Computerized Course. Manual for Higher Educational Institutions / V. I. Kaganov. - 2nd ed., revised and supplemented - Moscow: FORUM: INFRA-M, 2013. - 431 p. : ill.; 25. - (Higher Education. Bachelor's Degree). - Grief: Add. MO. - References: p. 423-426. - ISBN 978-5-91134-719-2. - ISBN 978-5-16-006471-0 – 15 copies.
3. Fedosov V.P. Radiotekhnicheskie tsepi i signaly: uchebnoe posobie [Radio engineering chains and signals: a textbook]. - Rostov-on-Don[Taganrog: Publishing House of the Southern Federal University, 2017. - 283 p.: ill. - <http://biblioclub.ru/>. - Refs.: p. 274. - ISBN 978-5-9275-2481-5, unlimited copies.
4. Evdokimov A.O., Okhotnikov S.A. Radiotechnical Chains and Signals: Collection of Tasks and Exercises: Textbook; Volga State Technological University, 2. - Yoshkar-Ola: PSTU, 2017. - 96 p.: graphs, schemes. - <http://biblioclub.ru/>. - Bibliogr. in the book. - ISBN 978-5-8158-1750-0. - ISBN 978-5-8158-1887-3 (Part 2), unlimited copies.
5. Kozlov V.A. Radiotechnical Chains and Signals Elektronnyi resurs [Radio Engineering Chains and Signals]. - 2nd ed., revised and supplemented - Kazan: KNRTU-KAI, 2017. - 84 p. - Recommended for publication by the Educational and Methodological Department of KNRTU-KAI. - ISBN 978-5-7579-2290-4, unlimited copies.

7.1.2. List of additional literature:

1. Akulinichev Yu.P., Bernagrdt A.S. Theory and Technique of Information Transmission [Elektronnyi resurs]: uchebnoe posobie [Theory and Technique of Information Transmission]: Textbook / Yu.P. Akulinichev, A.S. Bernagrdt. – Electron. tekstovye danny. – Tomsk: Tomsk State University of Control Systems and Radioelectronics, El Content, 2012. – 210 p. – 978-5-4332-0035-7. – Mode of access: <http://www.iprbookshop.ru/13984.html>, copies are unlimited.
2. Radio Engineering Circuits and Signals. Laboratory Workshop [Elektronnyi resurs]: uchebnoe posobie / V. Y. Baskey, V. M. Merenkov, D. O. Sokolova, A. N. Yakovlev; ed. A. N. Yakovlev. — Electron. tekstovye dannye. — Novosibirsk: Novosibirsk State Technical University, 2014. — 113 p. — 978-5-7782-2395-0. — Mode of access: <http://www.iprbookshop.ru/45154.html>, copies are unlimited.
3. Umnyashkin S.V. Osnovy teorii tsifrovogo obrabotki signalov [Elektronnyi resurs]: uchebnoe posobie [Fundamentals of the theory of digital signal processing]: textbook / S. V. Umnyashkin.

— Electron. tekstovye dannye. — M.: Tekhnosfera, 2016. — 528 p. — 978-5-94836-424-7. — Rezhim dostupa: <http://www.iprbookshop.ru/58892.html>, soigranichov unlimited.

4. Yakovlev A. N. Osnovy teorii signalov v primeakh, uprazhneniyakh i zadaniyakh [Fundamentals of the theory of signals in examples, exercises and tasks]: a textbook / A. N. Yakovlev. — Electron. tekstovye dannye. — Novosibirsk: Novosibirsk State Technical University, 2012. — 470 p. — 978-5-7782-1995-3. — Mode of access: <http://www.iprbookshop.ru/45128.html>, copies are unlimited.

7.2. List of resources of the information and telecommunication network "Internet" necessary for the development of the discipline (module)

<http://www.ielectro.ru/products.html>: Novinki elektrotehnika [Novelties of electrical engineering].

<http://www.labcenter.com/index.cfm>.

<http://www.vsy-elektrotehnika.ru>

www.eLibrary.ru - Scientific Electronic Library

www.iprbookshop.ru - IPRbooks Electronic Library System

7.3 Methodical literature:

1. Nikulin V.I. Theory of Electrical and Radio Engineering Circuits: Analysis of Electrical Circuits in Established and Transitional Modes: Guidelines for the Implementation of Course Work. - Stavropol: NCFU, 2023.

2. Nikulin V.I. Teoriya elektricheskikh i radiotekhnicheskikh tsepey: Metodicheskie ukazaniya po ispolneniiu laboratornykh raboty [Theory of electrical and radiotechnical circuits: Guidelines for the performance of laboratory work]. - Stavropol: NCFU, 2023.

3. Practical Electrical Engineering: Fundamentals of Electrical Engineering Using MATLAB/Simulink. - Arkhangelsk: NArFU, 2014. - 414 p. - ISBN 978-5-261-00970-2

8. 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 equipment is used to demonstrate presentation multimedia materials.

In the course of laboratory work, students perform studies of electrical and radio circuits using computer simulation software and industrial laboratory installations.

Information reference systems:

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

1.	http://www.vsy-elektrotehnika.ru
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2.	http://www.ielectro.ru/products.html : Novinki elektrotehnika [Novelties of electrical engineering].
3.	http://www.labcenter.com/index.cfm .

Software:

1.	NI LabView Teaching Only.
2.	NI Multisim Education or Electronics Workbench.
3.	PTC Mathcad
4.	Airen test control program