Fundamentals of Circuit Theory

Curriculum of the academic discipline (Syllabus)

Course details

Level of higher education	**First (bachelor's)**
Field of knowledge	G – Engineering, manufacturing, and construction
Special	G5 Electronics, electronic communications, instrument engineering, and radio engineering
Educational program	Information and communication radio engineering
Status of discipline	Mandatory
Form of study	Full-time
Year of training, semester	2nd year, fall
Scope of the discipline	8 credits (lectures 60 hours, practical classes 44 hours, laboratory classes 16 hours, independent work 120 hours)
Semester control/control measures	Exam
Class schedule	
Language of instruction	Ukrainian
Information about course director / lecturers	Lecturer: Andriy V. Bulashenko, PhD in Technical Sciences, a.bulashenko@kpi.ua Practical classes: Andriy V. Bulashenko, PhD in Technical Sciences Laboratory: Candidate of Technical Sciences, Andriy V. Bulashenko, Assistant Boris V. Vandilovsky
Course location	https://do.ipo.kpi.ua/course/view.php?id=6668

Curriculum

Description of the academic discipline, its purpose, subject matter, and learning outcomes

The purpose of the credit module is to develop students' abilities to:

- perform calculations of electrical and electronic circuits of direct and alternating current, the ability to compile mathematical models and use computing technology for their calculations;
- calculate the basic parameters of various types of electronic circuits (oscillatory circuits, four-pole circuits, multipole circuits, long lines, etc.);
- perform circuit analysis in the frequency domain using the apparatus of circuit functions;
- formulate requirements for electronic circuit elements based on their functional purpose.

According to the requirements of the course, after completing the credit module, students should demonstrate the following learning outcomes:

knowledge of:

- the basic physical processes in direct and alternating current circuits, the correct application of equivalent circuits, and their mathematical modeling;
- the basic properties of electronic circuits and their elements in direct and alternating currents;
- methods of calculating electronic circuits (traditional and modern);
- study of methods and acquisition of skills in model research of the characteristics of functional elements of electronic devices.

Skills:

- calculate the modes of electronic circuits in direct and alternating current*;*
- widely apply engineering calculations and assessments*;*
- correctly select the nominal values of circuit element parameters to obtain the desired characteristics;
- perform calculations of electronic circuits with extensive use of computer technology.

General competencies

GC 1. Ability to think abstractly, analyze, and synthesize.
GC 2. Ability to apply knowledge in practical situations.
GC 4. Knowledge and understanding of the subject area and understanding of professional activity.
GC 8. Ability to identify, pose, and solve problems.

Professional competencies

PC 4. Ability to perform computer modeling of devices, systems, and processes using universal application software packages.

Program learning outcomes

PLO 1. Analyze, argue, and make decisions when solving specialized tasks and practical problems in telecommunications and radio engineering, which are characterized by complexity and incomplete certainty of conditions;
PLO 2. Apply the results of personal research and analysis of information to solve qualitative and quantitative problems of a similar nature in information and communication networks, telecommunications and radio engineering systems;
PLO 4. Explain the results obtained from measurements in terms of their significance and relate them to the relevant theory;
PLO 7. Competently apply the terminology of the telecommunications and radio engineering industry;
PLO 8. Describe the principles and procedures used in telecommunications systems, information and telecommunications networks, and radio engineering;
PLO 13. Apply fundamental and applied sciences to analyze and develop processes occurring in telecommunications and radio engineering systems;
PLO 18. Find, evaluate, and use information from various sources necessary for solving professional tasks, including reproducing information through electronic search;

Prerequisites and post-requisites of the discipline (place in the structural-logical scheme of training under the relevant educational program)

The discipline "Fundamentals of Circuit Theory" belongs to the cycle of general training of specialists in the specialty G5 Electronics, Electronic Communications, Instrument Engineering, and Radio Engineering. The discipline is related to many other disciplines. The prerequisite disciplines definitely include: "Analytical Geometry and Linear Algebra," "Higher Mathematics" (sections: mathematical analysis, series, functions of a complex variable, differential equations, operational calculus), "General Physics" (section on electromagnetism), "Fundamentals of Metrology," "Introduction to the Specialty." The discipline "Fundamentals of Circuit Theory" provides the basis for the study of all radio engineering disciplines taught later: "Signals and Processes in Radio Engineering," "Processes in Linear Electronic Circuits," "Circuit Engineering," "Electrodynamics and Radio Wave Propagation," etc.).

Contents of the academic discipline

3. Structure of the credit module

Names of sections and topics	Number of hours				
	Total	**Lectures**	**Pract.**	**Lab**	**SRC**
Section 1*. Linear electric circuits of direct current.*					
Topic 1.1. Basic concepts and laws of circuit theory.	8	2	2		4
Topic 1.2. Basic methods of circuit calculation.	32	8	8	2	14
Total for Section 1	**40**	**10**	**10**	**2**	**18**

Names of sections and topics	Number of hours				
	Total	Lectures	Pract.	Lab	SRC
Section 2. *Linear AC electrical circuits.*					
Topic 2.1. Periodic alternating current	2	1			1
Topic 2.2. Analysis of circuits in harmonic mode	34	11	8	2	13
Topic 2.3. Circuits with mutual inductance	8	2	2		4
Total for Section 2	**44**	**14**	**10**	**2**	**18**
Section 3. *Single oscillatory circuit*					
Topic 3.1. Series oscillatory circuit.	13	4	2	2	5
Topic 3.2. Parallel oscillatory circuit.	13	4	2	2	5
Topic 3.2. Contours with magnetic links.	4		2		2
Total for Section 3	**30**	**8**	**6**	**4**	**12**
Section 4. *Circuit functions, four-pole circuits, and the operator method*					
Topic 4.1. Circuit functions of simple circuits	10	2	4		4
Topic 4.2. Passive four-pole circuits	12	4	4		4
Topic 4.3. Calculation of transient processes in simple circuits	22	8	6	4	4
Total for Section 4	**44**	**14**	**14**	**4**	**12**
Section 5. *Linear electrical circuits with distributed parameters*					
Topic 5.1. Long lines in harmonic mode.	20	8	2	4	6
Topic 5.2. Coordination and transitions in the long line.	12	6	2		4
Total for Section 5	**32**	**14**	**4**	**4**	**10**
RR implementation	**20**				**20**
Exam	**30**				**30**
Total hours	**240**	**60**	**44**	**16**	**120**

Teaching materials and resources

Basic literature

1. Fundamentals of Circuit Theory. Lecture Course [Electronic resource]: textbook for bachelor's degree students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko. – Electronic text data (1 file: 7.27 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 418 p. (https://ela.kpi.ua/handle/123456789/67768).
2. Fundamentals of Circuit Theory. Collection of problems [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko; Igor Sikorsky Kyiv Polytechnic Institute. – 2nd ed., revised and supplemented. – Electronic text data (1 file, 4.9 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2024. – 180 p. (https://ela.kpi.ua/handle/123456789/67656).
3. Fundamentals of Circuit Theory. Recommendations for Calculations [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 2.61 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 80 p. (https://ela.kpi.ua/handle/123456789/54610).
4. Fundamentals of Circuit Theory. Laboratory Practicum. [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko, M. F. Mkhayan; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 2.1 MB). – Kyiv: Igor Sikorsky KPI, 2023. – 66 p. (https://ela.kpi.ua/handle/123456789/54223).

Supplementary literature

1. Fundamentals of Circuit Theory: A Textbook for Higher Education Students. Part 1 / Yu. O. Koval, L. V. Hrynchenko, I. O. Milyutchenko, O. I. Rybina; edited by V. M. Shokal and V. I. Pravda. – Kharkiv: Smith Company, 2008. – 432 p. Edited by V. M. Shokal and V. I. Pravda. – Kharkiv: Smith Company, 2008. – 432 p.
2. Fundamentals of Circle Theory: Textbook for Students of Higher Educational Institutions. Part 2 / Yu. O. Koval, L. V. Grinchenko, I. O. Milyutchenko, O. I. Rybina; edited by V. M. Shokal and V. I. Pravda. – Kharkiv: Smith Company, 2008. – 560 p.
3. Fundamentals of Circuit Theory. Calculation of Linear Direct Current Electrical Circuits. Practical Workbook. [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko; Igor Sikorsky KPI. – Electronic text data (1 file, 2.66 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 85 p.
4. Fundamentals of circuit theory. Calculation of linear AC electrical circuits. Practical exercises. [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 2.219 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 75 p.
5. Fundamentals of circuit theory. Calculation of single circuits. Practical exercises. [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 1.51 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 62 p.
6. Fundamentals of circuit theory. Calculation of circuit functions, four-pole circuits, and transient processes in simple circuits. Practical exercises. [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko. – Electronic text data (1 file, 2.81 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2019. – 65 p.
7. Fundamentals of circuit theory. Calculation of long lines. Practical exercises. [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 1.66 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 47 p. (https://ela.kpi.ua/handle/123456789/55122).
8. Fundamentals of Theory and Computer Modeling of Electronic Circuits: Textbook [Electronic resource]: textbook for students majoring in 172 Telecommunications and Radio Engineering / V. D. Stashuk, A. V. Bulashenko; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 6.58 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2019. – 400 p. (https://ela.kpi.ua/handle/123456789/30984).
9. Samkov O.V., Koval V.V., Zaitsev G.F. Fundamentals of Electrical Circuit Theory. Textbook: Edited by Samkov O.V. – Kyiv: Institute of Electrodynamics of the National Academy of Sciences of Ukraine. – 2023. – 513 p.
10. Fundamentals of Electronic Circuit Theory: Textbook / Edited by P.G. Stakhiv, Doctor of Technical Sciences, Professor. – Lviv: Magnolia 2006, 2025. – 296 p.
11. Baidak Yu.V. Fundamentals of Circuit Theory. Textbook. – Kyiv: Higher School: Slovo, 2009. – 271 p.
12. Gumen M.B. Fundamentals of Electrical Circuit Theory. In 3 volumes. Vol. 1. Analysis of Linear Electrical Circuits. Time Domain: Textbook. / M.B. Gumen, A.M. Gurzhiy, V.M. Spivak; Edited by M.B. Gumen. – Kyiv: Vyshcha Shkola, 2003. – 399 p.
13. Gumen M.B. Fundamentals of Electrical Circuit Theory. In 3 volumes. Vol. 2. Analysis of Linear Electrical Circuits. Frequency Domain: Textbook. / M.B. Gumen, A.M. Gurzhiy, V.M. Spivak; Edited by M.B. Gumen. – Kyiv: Vyshcha Shkola, 2004. – 358 p.
14. Theoretical Foundations of Electrical Engineering: Textbook: in 3 volumes. / Edited by I.M. Chyzenko, V.S. Boiko. – Kyiv: IVC "Publishing House "Polytechnika," 2004. - Vol. 1: Steady state of linear electrical circuits with concentrated parameters. –272 p.
15. Theoretical Foundations of Electrical Engineering: Textbook: in 3 volumes / edited by I. M. Chyzenko, V. S. Boiko. - Kyiv: IVC "Publishing House "Polytechnika", 2008. - Vol. 2. Transient processes in linear electrical circuits, nonlinear electrical and magnetic circuits. – 224 p.
16. Theoretical Foundations of Electrical Engineering: Textbook: in 3 volumes / V. S. Boiko, Yu. F. Vydolob, I. A. Kurylo, et al. – Kyiv: IVC "Publishing House "Polytechnika," 2013. – Vol. 3. Electrical circuits with distributed parameters. Theory of electromagnetic fields. – 224 p.
17. Theoretical Fundamentals of Electrical Engineering. Steady-state modes of linear electrical circuits with concentrated parameters [Electronic resource]: textbook for bachelors majoring in 141 "Electric Power Engineering, Electrical Engineering, and Electromechanics" / comp.: Yu. V. Peretyatko, Ye. O. Trotsenko, M. A. Shcherba. – Electronic text data (1 file: 6.21 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2025. – 227 p.
18. Trembach R.B. Theory of Electric and Magnetic Circuits. Textbook/ R.B. Trembach – Ternopil: TNEU, 2015 – 263 p.

Educational content

Methodology for mastering the academic discipline (educational component)

Lectures

Lectures are prepared in accordance with the basic source [1].

Lesson number	Lecture content	Number of hours
1	Basic concepts and laws of electrical circuit theory	2
2	Equivalent transformations of electrical circuits.	2
3	Basic methods for calculating electrical circuits: the loop current method and the node voltage method	2
4	Equivalent generator method and superposition method	2
5	The principle of reciprocity, the compensation theorem, and the concept of circuit functions	2
6	Periodic alternating and harmonic currents. Complex amplitude method	2
7	Passive elements in harmonic current circuits	2
8	Series and parallel connection of elements in harmonic current circuits	2
9	Ohm's and Kirchhoff's laws in harmonic current circuits	2
10	Passive two-terminal network in harmonic current circuits	2
11	Power in harmonic current circuits	2
12	Circuits with inductively coupled elements	2
13	Series oscillatory circuit	2
14	Analysis of a series circuit	2
15	Parallel oscillatory circuit of canonical form and its characteristics	2
16	Parallel oscillatory circuits of types 1, 2, and 3	2
17	Concepts of circuit functions and transfer four-pole networks	2
18	Equivalent circuits of four-terminal networks	2
19	The relationship between the parameters of a four-terminal network and the circuit connecting them	2
20	Transient processes, commutation laws, and properties of Laplace transformation	2
2	Operator method of transient process analysis	2
22	Time method of transient process analysis	2
23	Classical method of transient process analysis	2
24	Telegraph equations of long lines and their solutions	2
25	Analysis of long line transmission equations	2
26	Running wave mode and long line as a four-pole circuit	2
27	Steady wave mode of a long line	2
28	Mixed long line wave mode	2
29	Line matching with load	2
30	Transient processes in long lines	2
Total number of hours		60

Practical classes

The main objectives of the practical classes are to learn practical methods for solving basic problems in the analysis of radio-electronic devices using specific examples, to reinforce theoretical knowledge and apply it to research work, and to learn how to use computing technology competently. During practical classes, problems are solved according to a collection of problems from the basic source [2]. Examples of solved problems can be found in the manuals: [3], [4], [5], [6], [7] from additional sources.

Lesson number	Practical class content	Number of hours
1	Basic concepts and laws of circuit theory. Classroom: 1.2(a), 1.5(a), 1.7(a), 1.9, 1.10(a), 1.11(a,b); Homework assignment DZ-01: 1.2(b), 1.3, 1.5(b), 1.7(b), 1.10(b), 1.11(c,d).	2
2	Kirchhoff's laws and equivalent source transformations Classroom work: 1.11(k), 1.16(a), 1.15(a), 1.17(a,b); Homework assignment DZ-02: 1.15(b), 1.16(b), 1.17(c,d,e), 1.13, 1.18.	2
3	Contour current method (CCM), node voltage method (NVM), superposition principle, and reciprocity principle Classroom work: 1.20, 1.23, 1.27(a), 1.28(a), 1.30, 1.31; Homework assignment DZ-03: 1.21, 1.24, 1.27(b,c), 1.28(b), 1.29, 1.32.	2

4	Calculation of circuits with controlled sources Classroom work: 1.33, 1.36(a), 1.38(a), 1.40(a), 1.41(a), 1.42(a), 1.43(a); Homework assignment DZ-04: 1.34(c), 1.35(b), 1.38(b), 1.40(b), 1.41(d), 1.42(d), 1.43(c).	2
5	Equivalent generator method. Classroom: 1.46(a,b), 1.47(a), 1.49(a), 1.51(a,b), 1.53(a), 1.58(a), 1.59(b); Homework assignment DZ-05: 1.47(b), 1.49(c), 1.53(c,d), 1.58(b), 1.59(c).	2
6	Basic laws in simple alternating and harmonic current circuits. Classroom: 2.3(a), 2.6, 2.12(a), 2.13(a), 2.16(a,c), 2.17(a); Homework assignment DZ-06: 2.3(b), 2.5(c), 2.12(b), 2.13(b), 2.15(a,b), 2.16(b,d), 2.17(b).	2
7	Basic laws in complex harmonic current circuits. Classroom: 2.18(b), 2.20(a), 2.21(a), 2.24, 2.25(a), 2.27(a), 2.29(a), 2.30(a); Homework assignment DZ-07: 2.20(b), 2.21(b), 2.23(a,b), 2.25(b), 2.27(b), 2.29(b), 2.30(b).	2
8	Power, branch quality, and equivalent circuits in harmonic current circuits. Classroom: 2.33(a), 2.35(a), 2.36(a), 2.37(a), 2.38(a), 2.39(a), 2.41; Homework assignment DZ-8: 2.33(b), 2.35(b), 2.36(b), 2.37(b), 2.38(b), 2.39(b), 2.40(b,c).	2
9	Calculation of circuits using the equivalent generator method. Classroom: 2.42(a,b), 2.43(a), 2.44(a), 2.45(a,c), 2.46(b), 2.47(a); Homework assignment DZ-9: 2.43(b), 2.44(b), 2.45(b,d), 2.46(b), 2.47(b), 2.48(a).	2
10	Calculation of complex circuits and circuits with harmonic current magnetic couplings. Classroom: 2.50(a), 2.51(a), 2.52(a), 2.53(a), 2.54(a), 2.62(a), 2.63(a), 2.64(a); Homework assignment DZ-10: 2.50(b), 2.51(b), 2.52(b), 2.53(b), 2.54(b), 2.62(b), 2.63(b,c), 2.64(b).	2
11	Calculation of series circuits. Classroom: 3.2(a), 3.4(a), 3.5, 3.12(a), 3.13(a), 3.16(a), 3.17(a); Homework assignment DZ-11: 3.3, 3.6, 3.9(b), 3.12(b), 3.13(b), 3.16(b), 3.17(b).	2
12	Calculation of parallel circuits. Classroom assignments: 3.22(a,b), 3.23(a), 3.24(c), 3.25(a), 3.26(a), 3.29(a); Homework assignment DZ-12: 3.22(c), 3.24(b), 3.25(b), 3.26(b), 3.28(a), 3.29(c, d).	2
13	Calculation of contours with magnetic links. Classroom: 3.31(a), 3.32(a), 3.34(a,b), 3.36(a), 3.35, 3.43; Homework assignment DZ-13: 3.32(b), 3.33(b), 3.34(b, d), 3.36(b), 3.37.	2
	MCR-1. Calculation of direct and alternating current circuits	
14	Calculation of circuit functions of simple circuits. Classroom: 4.1(a), 4.3(a), 4.4(c); 4.5(a), 4.6(a); Homework assignment DZ-14: 4.1(b), 4.3(b), 4.4(d), 4.5(b), 4.6(b).	2
15	Calculation of circuit functions of complex circuits. Classroom: 4.7(a), 4.8(a), 4.10(a), 4.11(a), 4.23(a); Homework assignment DZ-15: 4.7(b), 4.8(b), 4.10(b), 4.11(c); 4.23(b).	2
16	Calculation of four-pole simple circuits. Classroom: 4.12(a), 4.13(a), 4.15(a); 4.16(a), 4.17(a), 4.18(a); Homework assignment DZ-16: 4.12(b), 4.14(a), 4.15(b), 4.16(b), 4.17(b), 4.18(b).	2
17	Calculation of four-pole complex circuits. Classroom: 4.19(a), 4.20(a), 4.21(a), 4.23(a), 4.26, 4.29; Homework assignment DZ-17: 4.19(b), 4.20(b,c); 4.21(b), 4.23(b), 4.27, 4.30.	2
18	Calculation of simple circuits using the operator method. Classroom: 5.1(a), 5.2(a), 5.3(a); 5.4(a), 5.5(e), 5.6(a); Homework assignment DZ-18: 5.1(b), 5.2(b), 5.3(b), 5.4(b), 5.5(g), 5.6(b).	
19	Calculation of time characteristics of circuits. Classroom: 5.7(a,e); 5.8(a, e), 5.9(a), 5.10(a), 5.11(a), 5.13(a); Homework assignment DZ-19: 5.7(b,g), 5.8(b,g), 5.9(b), 5.10(b), 5.11(b), 5.13(b).	2
20	Calculation of transient processes in circuits with switching using the operator method. Classroom: 5.15(a), 5.16(a), 5.17(a); 5.18(a), 5.19, 5.20; Homework assignment DZ-20: 5.15(b,c), 5.16(b), 5.17(b); 5.18(c,d), 5.21.	2
	MCR-2. Calculation of circuit functions, four-pole circuits, and the operator method	
21	Calculation of long lines. Lectures: 6.1, 6.5, 6.6, 6.10(a), 6.11(a), 6.12(a); 6.13(a), 6.14; Homework assignment DZ-21: 6.2, 6.7, 6.8, 6.10(b), 6.11(b), 6.12(b), 6.13(b).	
22	Calculation of matching modes and transient processes in long lines. Classroom: 6.16, 6.19(a); 6.20(a), 6.21(a); 6.24; 6.26, 6.30(a), 6.31(a); Homework assignment DZ-22: 6.17, 6.19(b), 6.20(b), 6.21(b), 6.30(b), 6.31(b).	2

Total number of hours	44

Laboratory work

The main objectives of the laboratory work cycle are the practical application of acquired knowledge and the acquisition of skills for independent work with equipment. The work is carried out in accordance with the laboratory work manual from the basic source [4].

The topics of the laboratory work are listed below:

No.	Name of laboratory work	Number of classroom hours
2	Basic laws of electrical circuits.	2
3	Simple circuits of harmonic current.	2
4	Series oscillatory circuit.	2
5	Parallel oscillatory circuit.	2
6	Transient processes in linear circuits.	4
7	Circuits with distributed parameters.	4
Total		16

Independent work of higher education applicants

Independent preparation can be carried out in accordance with the basic source [1] or additional sources [1, 2].

No	Title of the topic for independent study	Number of hours of independent study
1	Section 1. Linear electric circuits of direct current.	2
	Basic concepts of electrical circuit theory (charge, current, voltage, power, energy)	1
	Passive (resistance, capacitance, conductivity) and active (controlled and uncontrolled sources) elements of electrical circuits	2
	Electrical diagrams and their types. Classification of electrical diagrams and electrical circuits. Concepts of graph theory	2
	Basic laws of electrical circuit theory (Ohm's law, Kirchhoff's laws, power balance law)	4
	Current divider and voltage divider	1
	Equivalent transformations in electrical circuits (parallel and series transformations of passive and active elements, transformation of a current source into a voltage source, removal of a voltage source outside the node, separation of current sources in a circuit)	5
	Basic methods of calculating electrical circuits (contour current method, node voltage method, equivalent generator method, superposition principle, reciprocity principle, and compensation theorem)	5
2	Section 2. Linear AC electrical circuits.	20
	Basic concepts in harmonic current circuits	2
	Representation of harmonic oscillations by rotating vectors	2
	Method of complex amplitudes and operations with complex numbers	2
	Passive elements in harmonic current circuits	2
	Series and parallel connection of elements in harmonic current circuits	2
	Ohm's and Kirchhoff's laws in complex form	2
	Passive two-terminal network in harmonic current circuits	2
	Frequency characteristics of circuits and their types	2
	Power in harmonic current circuits	2
	Circuits with magnetic couplings	2
3	Section 3. Single oscillatory circuit	10
	Serial circuit of canonical type	2
	Frequency characteristics of a series circuit	2
	Parallel circuit of canonical form	2
	Parallel circuit of the first type	2
	Parallel contour of the second and third type	2
4	Section 4. Circuit functions, four-pole networks, and the operator method	10

	Circuit functions, their types, and definition of circuit functions	2
	Definition of circuit functions based on the resistance and conductance matrix	2
	Concept of four-pole circuits, their types and classification	2
	Equivalent circuits and connections of four-terminal networks	2
	Decomposition theorem and Laplace table	2
5	Section 5. Linear electrical circuits with distributed parameters	10
	Telegraph equations and their solution for harmonic mode	2
	Equation of a long line as a four-pole	2
	Wave processes in a line	2
	Matching the line to the load	2
	Transient processes in long lines	2
	Execution of RR	2
	Preparation for the exam	30
	Total hours	12

Individual assignments

One calculation assignment (CA) is provided: "Calculation of linear electrical circuits." The main goal is to reinforce the theoretical course through practical, independent work by performing specific calculations.
The following tasks are performed in the CR:

- calculation of a direct current circuit;
- calculation of a harmonic current circuit;
- calculation of a single oscillatory circuit.

The tasks for the CR are given individually to each student from the basic source [3].

Policy and control

Policy of the academic discipline (educational component)

Rules for attending classes (both lectures and practical/laboratory classes)
All types of classes are mandatory: lectures, practical classes, and laboratory classes. Completion of all laboratory work is mandatory. If these classes are missed, they must be made up during consultations or with other groups.
Defense of laboratory work
Laboratory work is defended on the day the laboratory work is completed. The defense takes the form of an interview. A mandatory condition for admission to the defense is the availability of a formal protocol, which contains the results of the completed laboratory work in the form of corresponding graphs and calculations or screenshots of measurements in the case of remote work.
Completion and defense of the calculation work (CW)
As part of their independent work, students complete the CR assignment according to the option. Based on the results of the check, if the work is completed correctly, the student is assigned a date for the CR defense. The defense takes the form of an interview. Repeated CR defenses are not provided for.
Incentive and penalty points and academic integrity policy
Any type of assessment, except for lab work, can be replaced with incentive rating points for winning prizes (1, 2, 3) in a subject competition. Or by preparing abstracts for international scientific conferences on radio engineering in English and presenting a report at the conference: 1 abstract – 5 points (as agreed with the lecturer). Participation in the Olympiad is evaluated from 0 to 5 points depending on success
Penalty points are applied in the case of passing off someone else's work as your own, with mandatory subsequent reworking.
Deadline and resit policy
If the deadlines for submitting assignments are missed, the maximum score for the assignments is reduced by 10% for course participants.
Class attendance
Attendance at lectures, practical classes, and laboratory classes is in accordance with the Regulations on the Organization of the Educational Process at Igor Sikorsky KPI. At least once every two weeks, the instructor holds consultations on various issues related to the credit module. During consultations, the instructor can provide assistance in studying the material of classes that students have missed for various reasons and must master on their own.
In any case, students are encouraged to attend all types of classes, as they cover theoretical material and develop the skills necessary to complete homework, laboratory work, and calculations.
Announcement of test results
The defense of the completed section of the RR takes the form of an interview with the teacher. During the defense, the student must be able to explain the results obtained and answer the main theoretical questions on the topics of the sections. The results of the defense are announced to the student in their presence or remotely and are accompanied by specific comments and remarks regarding errors (remote communication via Zoom, Telegram with video and audio).
The results for the completed homework assignment are posted after its completion and defense, no later than the next class.
Missed tests
The result for a student who did not attend the test is zero. If a student misses a test for a valid reason, they are given the opportunity to take it (write a module test) in the presence of the teacher. If the absence was without a valid reason, the issue of making up the test is decided with the teacher in consultation with the department management. A missed test is not counted regardless of the reasons for the absence; in this case, the student receives a "did not show up" mark, and if they are eligible to take the test, they must take it during an additional session.
Academic integrity
The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute." For more details, see: https://kpi.ua/code.
Standards of ethical conduct
The standards of ethical conduct for students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute." For more information, visit: https://kpi.ua/code.
Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the procedure for conducting and/or evaluating tests and expect that it will be considered in accordance with pre-defined procedures.
Students have the right to appeal the results of assessment measures, but must provide a reasoned explanation of which criteria they disagree with according to the assessment sheet and/or comments.

Types of assessment and the learning outcomes assessment rating system (LOAS)

Semester assessment: exam

Conditions for admission to semester assessment: completion of calculation work and laboratory work.

Control measures and distribution of points in the semester Rsem

Type of assessment	Explanation	Maximum score	Deadline for completion/submission
MCR	**Total score for all MCRs**	**10**	
	MCR-1. Calculation of direct and alternating current circuits	5	according to the schedule
	MCR-2. Circuit functions, four-pole circuits, and the operator method	5.0	according to schedule
PP	**3 parts, 5 points each**	**15**	
	RR, Part 1. Calculation of a direct current circuit	5	according to the schedule
	RR, Part 2. Calculation of a harmonic current circuit	5.0	according to schedule
	RR, Part 3. Calculation of a single circuit	5.	according to schedule
Lab work	**Total score for all work**	**25**	
	LR-2. Basic laws of electrical circuits	5	according to schedule
	LR-3. Simple circuits of harmonic current	5.0	as scheduled
	LR-4. Series oscillatory circuit	2.5	according to schedule
	LR-5. Parallel oscillatory circuit	2.5	according to schedule
	LR-6. Transient processes in linear circuits	5.	according to schedule
	LR-7. Circuits with distributed parameters	5.	according to schedule
Total score for the semester		**50**	
Exam	**3 questions on the exam: theory and problems**	**50**	According to schedule
Overall score for the discipline		**100**	after the exam

MCT – modular control test, involves solving practical problems according to the topics of the discipline;
RR – calculation work, involves performing calculation work according to the task option and defending it in the form of an interview;
Lab work – laboratory work, involves performing laboratory work according to the task option and defending it in the form of an interview.

Topics for MCR and their assessment

MCT number	Task topics	Total score
MCR-1. Calculation of direct and alternating current circuits	1. Calculation of direct current circuits	5
	2. Calculation of harmonic current circuits	
	3. Calculation of single circuits.	
MKR-2. Circuit functions, four-pole circuits, and the operator method	1. Calculation of circuit functions for simple circuits	5
	2. Calculation of four-pole networks of simple circuits	
	3. Calculation of circuits using the operator method.	

Table of correspondence between rating points and university scale grades:

Number of points	*Grade*

100-95	Excellent
94	Very good
84	Good
74-65	Satisfactory
64-60	Sufficient
Less than 60	Unsatisfactory
Admission requirements not met	Not admitted

Additional information on the discipline (educational component)

Questions for exam preparation.

1. Basic concepts of circuit theory.
2. Passive and active elements of electrical circuits. Classification of electrical circuits and concepts of graph theory.
3. Basic laws of circuit theory. Current divider and voltage divider.
4. Equivalent transformations of passive elements of electrical circuits.
5. Equivalent transformations of active elements of electrical circuits.
6. Contour current method. Algorithm of the method and consideration of controlled sources.
7. Node voltage method. Algorithm of the method and consideration of controlled sources.
8. Equivalent generator method. Condition for maximum power transfer to the load.
9. The principle of superposition, the principle of reciprocity, and the compensation theorem.
10. Basic concepts in harmonic current circuits.
11. The method of complex amplitudes. The concept of complex numbers and operations on them.
12. Passive elements in harmonic current circuits.
13. Series connection of elements in harmonic current circuits. The concept of impedance.
14. Parallel connection of elements in harmonic current circuits. The concept of admittance.
15. Ohm's and Kirchhoff's laws in harmonic current circuits.
16. Passive two-terminal network in harmonic current circuits.
17. Frequency characteristics of electrical circuits and their types.
18. Power in harmonic current circuits. Power triangle. Power factor.
19. The concept of branch quality. The law of power balance in harmonic current circuits.
20. Construction of vector diagrams in harmonic current circuits.
21. Circuits with inductively coupled elements. The concept of inductive coil polarity and its consideration in calculations.
22. Transformers in harmonic current circuits.
23. Series circuit. Basic concepts: selectivity, resonance, circuit parameters.
24. Frequency characteristics of a series circuit.
25. The effect of load resistance on the characteristics of a series circuit.
26. Parallel circuit of canonical form.
27. First type of parallel circuit: basic parameters and characteristics.
28. Parallel circuit of the second type: basic parameters and characteristics.
29. Parallel circuit of the third type: main parameters and characteristics.
30. Concept of circuit functions and their types. Classification of circuit functions.
31. Determination of circuit functions by the matrix of resistances and conductances.
32. Concept of four-pole circuits and their classification. Operating modes of four-pole circuits. Systems of four-pole circuit parameters.
33. Relationship between the parameters of a four-terminal network (between Y and Z; between Y and h).
34. Equivalent circuits of four-terminal networks and their physical meaning (Z-parameters, Y-parameters, h-parameters, A-parameters; F-parameters).
35. Circuits for connecting four-pole circuits, determination of their general parameters.
36. The concept of commutation and the transient process. Commutation laws and their proof. Consequences of commutation laws.
37. Operator method: Laplace transform and basic properties of Laplace.
38. Dirac and Heaviside functions and their properties.
39. Operator circuits for passive and active elements.
40. Ohm's and Kirchhoff's laws in operator form.
41. Finding the original. Decomposition theorem for simple roots and complex roots.

42. Classical method of calculating transient processes. General method of calculating circuits using the classical method. The concept of free and forced modes.
43. Connecting RL and RC circuits to a constant voltage. The concept of circuit time constant.
44. Time characteristics of a circuit (impulse and transient) and their calculation.
45. Time method for calculating transient processes. Duhamel's integral.
46. Circles with distributed parameters and their classification. Telegraph equations and their derivation.
47. Primary and secondary parameters of a long line.
48. Solution of telegraph equations from the beginning of the line. Analysis of transmission equations: incident and reflected waves. Wavelength and phase velocity
49. Solution of telegraph equations from the end of the line: analysis of transmission equations from the end of the line.
50. Construction of voltage and current distribution amplitudes along the line. Determination of the distance to the first minimum and maximum.
51. Line equation as a four-pole.
52. Running wave mode: line without distortion and loss and line loaded with wave resistance.
53. Steady wave mode of a lossless line: no-load and short-circuit modes, line loaded with reactive impedance.
54. Mixed wave mode.
55. Methods of matching the line to the load.
56. Transient processes in lines.

Working program of the academic discipline (syllabus):

Compiled by senior lecturer, candidate of technical sciences, Andriy Vasylovych Bulashenko

Approved by the Department of Radio Engineering (Minutes No. 06/2025 dated 06/23/2025)

Approved by the Methodological Commission of the RTF Faculty (Minutes No. 6/2025 dated 26.06.2025)