Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Radio Engineering

[RE-13] PROCESSES IN LINEAR ELECTRONIC CIRCUITS

Course syllabus (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	G - Engineering, manufacturing, and construction
Special and radio engineering	G5 - Electronics, electronic communications, instrument engineering,
Educational program	All
Discipline status	Elective (F-catalog)
Form of higher education	Full-time
Year of training, semester	Available for selection starting from the 2nd year, spring semester
Scope of the discipline	4 credits (Lectures 16 hours, Practical classes 30 hours,
Laboratory work 74 hours)	
Semester	
Control/control measures	Credit
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian
Information about the course leader/teachers	Lecturer: A. V. Bulashenko, Lab: A. V. Bulashenko, Independent work: A. V. Bulashenko
Course location	https://do.ipo.kpi.ua/course/view.php?id=678

Curriculum

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

The academic discipline "Processes in Linear Electronic Circuits" is a logical continuation of the discipline "Fundamentals of Circuit Theory" (FCT) and is a discipline of the professionally-oriented cycle of training specialists in the specialty "Telecommunications and Radio Engineering." This course is the foundation for training radio engineers and is closely related to many other courses. Credit module "Processes in Linear Electronic Circuits," together with circuit theory, provides the basis for the study of all radio engineering disciplines taught later. The purpose of the credit

module is to develop students' abilities to:

- perform calculations of electrical and electronic circuits when the source (current or voltage) is any function of time, competently compile mathematical models and use computing technology to process them;
- evaluate the expected results of circuit research in steady states and under arbitrary action;
- calculate the main parameters of various types of electronic circuits in the operator, frequency, and time domains, analyze these circuits with extensive use of circuit functions;
- perform tasks of synthesizing linear circuits according to specified characteristics in the presence of a certain element base (dipoles, gyrators, bistores, filters with Butterworth, Chebyshev approximation, etc.);

Mastering the PLES course provides students with:

knowledge of:

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

Skills:

- calculate the modes of electronic circuits at direct, harmonic, and any current in linear circuits with concentrated parameters;
- widely apply engineering calculations and assessments developed by previous generations; • experimentally study the characteristics of basic radio-electronic circuits and provide theoretical justification for them
- competently select the nominal parameters of circuit elements to obtain the desired characteristics.

Experience:

- performing calculations of electronic circuits with extensive use of computers; • model research of radio-electronic circuit characteristics.

***General competencies**:*

PC 1 Ability to think abstractly, analyze, and synthesize

PC 2 Ability to apply knowledge in practical situations.

***Professional competencies**:*

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

PC 18 Ability to analyze, evaluate characteristics, and design modern low-noise microwave receivers for information and communication systems.

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 25 Perform calculations of transient processes in electronic circuits with concentrated parameters, apply circuit function apparatus to study the frequency and time characteristics of radio-electronic circuits.

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

The study of the discipline PLES is based on the competencies acquired during the study of the following disciplines: "Higher Mathematics," "General Physics" (section "Electricity and Magnetism"), and, first of all, "Fundamentals of Circuit Theory." The credit module "Processes in Linear Electronic Circuits" together with circuit theory provide for the study of all radio engineering disciplines without exception, which are taught later.

Knowledge and skills in using the following are required:

1. Text editors for printing calculations.
2. Using MathCAD for technical calculations and graphical representation of their results.
3. Searching for functional elements using Google or similar search engines.
4. Technical English (for using English-language software).

3. Course content

Names of sections and topics	Number of hours				
	Total	including			
		Lectures	Practical (seminar)	Laboratory (computer practicum)	SRC
1	**2**	**3**	**4**	**5**	**6**
Section 1. SF devices in linear circuits					
Topic 1.1. Methods and algorithms for SF formation	7	4	2		1
Topic 1.2. Analysis of CTP using SF	15	4	2	8	1
MCR for section 1	1				1
Total for Section 1	**23**	**8**	**4**	**8**	**3**
Section 2. Processes in first- and second-order linear circuits					
Topic 2.1 Calculation of circuits using operator and time methods	5	2	2		1
Topic 2.2. Transient processes in first- and second-order linear circuits second order	11	8	2		1
MCR under section 2	1				1
Total for Section 2	**17**	**10**	**4**		**3**
Section 3. Elements of spectral analysis.					
Topic 3.1. Spectral analysis of simple signals	10	2	1	6	1
Topic 3.2. Passage of harmonic periodic signals through linear circuits	4	2	1		1
MCR under Section 3	1				1

1	2	3	4	5	6
Total for section 3	**15**	**4**	**2**	**6**	**3**
Section 4. Processes in coupled circuits					
Topic 4.1. Coupled oscillatory circuits	20	8	4	4	4
MCR under Section 4	1				1
Total for Section 4	**21**	**8**	**4**	**4**	**5**
Section 5. Elements of synthesis of linear analog circuits.					
Topic 5.1. Synthesis of two-pole circuits	5	2	2		1
Topic 5.2. Element base for synthesizing active circuits	4	2	1		1
Topic 5.3. Approximation of frequency response	4	2	1		1
MCR from section 5	1				1
Total for Section 5	**14**	**6**	**4**		**4**
Exam	**30**				**30**
Total hours	**120**	**36**	**18**	**18**	**48**

4. Teaching materials and resources

Basic recommended literature

1. Processes in linear electronic circuits. Lecture course [Electronic resource]: textbook for students majoring in 172 Electronic Communications and Radio Engineering / A. V. Bulashenko, M. I. Yastrebov; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 3.88 MB). – Kyiv: Igor Sikorsky Kyiv P o l y t e c h n i c Institute, 2023. – 157 p.
2. Fundamentals of Circuit Theory: Textbook for Students of Higher Educational Institutions, Part 2 / Yu.
3. O. Koval, L. V. Grinchenko, I. O. Milyutchenko, O. I. Rybin. SMIT Company, 2008. – 560 p.
4. Processes in Linear Electronic Circuits. Collection of Problems [Electronic resource]: textbook for students majoring i n 172 Electronic Communications and Radio Engineering / A. V. Bulashenko; Igor Sikorsky KPI. – Electronic text data (1 file, 3.1 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 132 p.
5. Processes in linear electronic circuits. Laboratory workshop. [Electronic resource]: textbook for students majoring i n 172 Electronic Communications and Radio Engineering / A. V. Bulashenko, M. F. Mkhayan, M. I. Yastrebov; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 1.5 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 40 p.
6. Processes in linear electronic circuits. Calculation of circuits using a circuit function device. 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, 2.09 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 66 p.
7. Processes in linear electronic circuits. Calculation of transient processes in first- and second-order 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, 2.108 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 75 p.
8. Processes in linear electronic circuits. Fundamentals of spectral analysis. Practical exercises. [Electronic resource]: textbook for students majoring in 172 Telecommunications and Radio Engineering / A. V. Bulashenko; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file, 1.939 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2020. – 54 p.
9. Processes in linear electronic circuits. Calculation of coupled 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, 1.31 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 42 p.
10. Processes in linear electronic circuits. Elements of synthesis. Practical exercises. [Electronic

11. 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, 2.06 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 60 p.
12. Fundamentals of Theory and Computer Modeling of Electronic Circuits: Textbook [Electronic resource]: textbook for students majoring in 172 "Telecommunications and Radio Engineering" / V.
13. 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.

Recommended supplementary reading

1. Theoretical Foundations of Electrical Engineering: Textbook: in 3 volumes / edited by I. M. Chyzenko, V. S. Boiko. - Kyiv: IVC "Publishing House "Polytechnika," 2004. – Vol. 2: Transient processes in linear electrical circuits with concentrated parameters. Nonlinear and magnetic circuits. – 224 p.
2. Theoretical Foundations of Electrical Engineering. Transient Processes in Linear Circuits. Synthesis of Linear Circuits. Electrical and Magnetic Nonlinear Circuits: Textbook / Yu. O. Karpov, Yu. G. Vedmitsky, V.

V. Kukharchuk, S. Sh. Katsiv; edited by Prof. Yu. O. Karpov. – Vinnytsia: VNTU, 2012. – 530 p. https://iq.vntu.edu.ua/fdb/671/Books/TOE_II_(1).pdf.

3. Fundamentals of Electronic Circuit Theory: Textbook (second edition: revised and expanded) / Yu. Ya. Bobalo, B. A. Mandziy, P. G. Stakhiv, L. D. Pysarenko, Yu. I. Yakimenko; Edited by Prof. Yu. I. Yakimenko. – Kyiv: Publishing House of the National Technical University of Ukraine "Kyiv Polytechnic Institute," 2011. – 332 p. ISBN 978-966-622-481-4 https://lpnu.ua/sites/default/files/2015/6/10/news/9653/tytlzmist.pdf
4. Forkun Y. B., Glebov M. L.. Lecture notes from the course "Theory of Electric and Magnetic Circuits" (for students of all forms of education in specialty 151 – Automation and Computer-Integrated Technologies) / – Kharkiv: O. M. Beketov National University of Water and Environmental Engineering, – 2017. – 124 p.
5. Fundamentals of Circuit Theory: Textbook for Students of Higher Educational Institutions, Part 1 / Yu. O. Koval, L. V. Grinchenko, I. O. Milyutchenko, O. I. Rybin. SMIT Company, 2008, – 432 p.
6. Fundamentals of Circuit Theory: Textbook for Higher Education Students, Part 2 / Yu. O. Koval, L. V. Grinchenko, I. O. Milyutchenko, O. I. Rybin. SMIT Company, 2008, 560 p.

Educational content

5. Methodology for mastering the academic discipline (educational component)

5.1. Lectures

Lectures are conducted in accordance with the manual [1].

No	Lecture topic and list of key questions (list of teaching aids, references to literature, and assignments for independent study)
	Section 1. SF apparatus for linear circuits.
	Topic 1.1. Methods and algorithms for forming SF.
1	Methods and algorithms for forming circuit functions. The concept of an operator circuit function (CF), types of CFs and their application. Finding CFs for Y and Z matrices.
2	Frequency characteristics of circuit functions. The concept of a zero and pole map. Construction of frequency characteristics using a zero and pole map.
3	Criteria for the stability of circuit functions. Mikhailov's frequency criterion. Raus-Gurvich method. Gurvich method. Raus criterion.
	Topic 1.2. Analysis of four-pole circuits using circuit functions.
4	System of four-pole parameters and their equivalent circuits.
5	Determination of four-terminal network parameters and feedback. Determination of four-terminal network parameters using the conductance matrix. Decomposition of the determinant by parameter. Feedback in four-terminal networks and its types. Circuit with sequential voltage feedback.
	Section 2. Processes in first- and second-order linear circuits **Topic 2.1. Calculation of complex circuits using operator and time methods**

6	Concepts of transient processes, commutation laws, and consequences. Basic principles of circuit analysis using the operator method. Some properties of Laplace transformation. Operator circuits for resistance, inductance, and capacitance substitution. Decomposition theorem for complex and multiple roots. Time characteristics of circuits, their relationship.
	Topic 2.2. Transient processes in first- and second-order linear circuits
7	Transient processes in series RL and RC circuits. Transient processes in RL and RC circuits (connection to constant and harmonic voltage, disconnection). Circuit time constant.
8	Transient processes in a series RCL circuit. Free discharge of capacitance in an oscillatory circuit (for different quality factors). Limit aperiodic discharge of capacitance. Oscillatory discharge of capacitance.
9	Transient processes in RLC circuits. Circuit connection under constant and harmonic voltage.
	Section 3. Elements of spectral analysis
	Topic 3.1. Spectral analysis of simple signals
10	Fourier series. Trigonometric and complex forms of representation. Power distribution in the spectrum. Transition to the spectrum of a non-periodic signal. Inverse and direct Fourier transforms. Spectral density function (SDF). Properties of SDF, theorems about spectra. Spectrum of a rectangular pulse. Energy distribution in the spectrum (spectrum width).
	Topic 3.2. Passage of harmonic periodic signals through linear circuits.
11	Finding the response to an arbitrary action using the spectral method. (Consider the following cases: passage without distortion, *very* short pulse, integrating and differentiating circuits). Spectra of some functions that are not absolutely integrable
	Section 4. Processes in coupled circuits
	Topic 4.1. Coupled oscillatory circuits
12	Types of coupled circuits, their coupling coefficient. Generalized two-circuit diagram: different relationships for currents, reduction of the diagram to the 1st and 2nd circuits, added resistances. Tuning coupled circuits to resonance.
13	Frequency characteristics of coupled circuits. Graphical analysis. Matanalysis of FC: determination of resonance frequencies, study of the AC response of current I2 when the quality factors are different.
14	Passband of coupled circuits. Determination of the passband depending on the coupling factor.
	Section 5. Elements of synthesis of linear analog circuits
15	Tasks and stages of synthesis. Synthesis of passive two-pole circuits: properties of input functions, positive real Brune function, Hurwitz polynomials. Synthesis according to Foster Zin and Yin.
16	Synthesis according to Kauder based on the input resistance and input conductance functions (different methods of dividing polynomials).
17	Element base for the synthesis of active circuits: operational amplifiers, gyrators, bistators, and their implementation.
18	Approximation of frequency characteristics of the transfer coefficient according to Butterworth and Chebyshev.

5. Practical classes

The main objectives of the practical classes are to learn how to solve basic problems in the analysis of radio-electronic devices using specific examples, to reinforce theoretical knowledge and apply it in research work, and to use computing technology competently. During practical classes, problems are solved according to the collection of problems [3]. Classroom and homework problems are selected from the list provided in the table for each topic, but their number may be changed by the instructor conducting the practical classes. Examples of solved problems are presented in manuals [5] - [9].

Number Class	Lesson topic and problems to be solved
1	Schematic function apparatus for linear circuits (deadline for submission – Practice 2)
	Lecture: 1.1(a), 1.2(a), 1.4(a), 1.6(a), 1.7(a), 1.9(a), 1.13(a), 1.15(a), 1.18(a), 1.20(a)
	Homework: 1.2(b), 1.3(a), 1.4(b), 1.6(b), 1.7(b), 1.8(a), 1.9(b), 1.12(a), 1.13(b), 1.15 (b), 1.18(b), 1.19(b), 1.20(b), 1.21(b); Additional: 1.1(b), 1.3(b), 1.6(c,d), 1.8(b), 1.12(b), 1.16(a, b), 1.18(c), 1.19(c,d), 1.20(c,d).
	Calculation of four-pole complex circuits (deadline for submission – Practice 3)

2	Lecture halls: 1.22, 1.23(a), 1.24(a), 1.27(a), 1.29(a), 1.30(a), 1.31(a), 1.32, 1.36(a), 1.41;
	Homework: 1.23(b), 1.24(b), 1.25(a), 1.27(b), 1.28(a), 1.29(b), 1.30(b), 1.31(b), 1.36(b), 1.38; Additional: 1.25(b), 1.28(b), 1.29(c,d), 1.32(c), 1.33, 1.37(a,b), 1.44.
[1] MCW-1	Apparatus of circuit functions in linear circuits (deadline for writing – after Practice 3)
3	Calculation of complex circuits using operator and time methods (submission deadline – Practice 4)
	Classroom: 2.1(a), 2.2(a), 2.4(a), 2.5(b), 2.6(a), 2.7(a), 2.8(a), 2.10(a);
	Homework: 2.1(b), 2.2(b), 2.4(b), 2.5(c), 2.6(b), 2.7(b), 2.8(b), 2.9, 2.10(b), 2.12; Additional: 2.2(c, d), 2.3(a, b), 2.4(a), 2.5(a), 2.6(c, d), 2.11.
4	Calculation of circuits with switching using the classical method (deadline – Practice 5)
	Classroom assignments: 2.13(a), 2.14(a), 2.17, 2.19, 2.20(a), 2.22(a), 2.23(a), 2.27;
	Homework: 2.13(b), 2.14(b), 2.15(a), 2.16(c), 2.18(c), 2.20(d), 2.22(b), 2.23(b), 2.26, 2.36; Additional: 2.15(b,d), 2.16(d), 2.18(d), 2.20(e,f), 2.22(c,d), 2.30, 2.34.
[1] MCW-2	Processes in first- and second-order diagrams (deadline for writing – after Practice 5)
5	Fundamentals of spectral analysis (submission deadline – Practice 6)
	Lectures: 3.1(a), 3.2(b), 3.6(a,b), 3.7(a), 3.10, 3.11(a), 3.12(a), 3.14(a), 3.15(a), 3.20(a);
	Homework: 3.1(b), 3.2(a), 3.3(b), 3.7(b), 3.11(b), 3.12(b), 3.14(b), 3.15(b), 3.19, 3.20(b); Additional: 3.3.(a,d), 3.5, 3.8(a, b), 3.9 (a, b), 3.12 (c,e), 3.14(c,d), 3.16, 3.18, 3.21.
[1] MCW-3	Elements of spectral analysis (deadline for writing – after Practice 6)
6	Calculation of contours with magnetic connections (submission deadline – Practice 7)
	Classroom: 4.1, 4.2(b), 4.3(a), 4.4, 4.6(a), 4.7(a), 4.8(a);
	Homework: 4.2(a,b), 4.3(b), 4.5, 4.6(b), 4.7(b), 4.8(b); Additional: 4.2(d).
7	Calculation of connected contours (deadline for submission – Practice 8)
	Classroom: 4.9(a), 4.10(a), 4.12(a), 4.13(c), 4.14(a), 4.15(a), 4.16. 4.19;
	Homework: 4.9(b), 4.10(b), 4.11, 4.12(b), 4.13(a,b), 4.14(b), 4.15(b), 4.17, 4.18(a); Additional: 4.18(b).
[1] MCW-4	Processes in connected circuits (deadline for writing – after Practice 8)
8	Synthesis of passive two-pole circuits according to Foster and Cauer and approximation of frequency characteristics of the transfer coefficient according to Butterworth and Chebyshev (submission deadline – Practice 9)
	Lectures: 5.1(a,b), 5.2(a), 5.3(a), 5.5(a,c), 5.6(a), 5.7(a), 5.8(a); 5.10, 5.12, 5.14, 5.16;
	Homework: 5.1(c,d), 5.2(b), 5.3(b), 5.5(b,d), 5.6(b), 5.7(b), 5.8(b), 5.11, 5.13, 5.15; Additional: 5.2(c), 5.4(a,b), 5.7(c), 5.17.
9	Synthesis of active two-pole circuits (deadline – after Practice 9)
	Classroom: 5.19(a), 5.20(a), 5.21(a), 5.22, 5.24(a), 5.25(a), 5.26(a), 5.27(a);
	Homework: 5.19(b), 5.20(b), 5.21(b), 5.23, 5.25(b), 5.26(b), 5.27(b).
[1] MCW-5	Fundamentals of Synthesis (deadline for submission – after Practice 9)

5. Seminar classes

Seminar classes are not included in the curriculum.

6. Laboratory classes (computer workshop)

The main objectives of the laboratory classes are the practical application of acquired knowledge and the acquisition of skills for independent work with equipment.

Laboratory work is carried out in accordance with the laboratory work manual [4].

No.	Name of laboratory work	Number of classroom hours
1	Passive four-pole networks	4
2	Frequency characteristics of circuit functions	4
3	Coupled oscillatory circuits.	4
4	Linear selective circle under periodic non-harmonic action.	6
	Total hours	**18**

6. Independent work

Independent work by students includes studying lecture materials on the SRC and completing homework assignments in practical classes.

In order to better assimilate the course material, a homework assignment (HAA) is planned. To prepare for the HAA, students should use the recommended literature, lecture notes, and the HAA guidebook. Individual assignments are given by the practical class instructor, who also sets deadlines for their completion. The HTA includes:

1. Calculation of the circuit in the frequency domain;
2. Calculation of the circuit in the time domain;
3. Spectral analysis.

The questions for independent study are listed in the table.

No.	Title of the topic for independent study	Number of hours of independent study
1	Section 1. Circuit function apparatus in linear circuits Literature: [3], [6].	**3**
	Types of feedback	1
	Methods of circuit function stability: Raus-Gurvich method, Gurvich method, Raus method	1
	Preparation for MCW	1
2	Section 2. Processes in first- and second-order linear circuits References: [3], [6].	**3**
	Connecting an RC circuit to a harmonic voltage	1
	Connecting an oscillatory circuit to a harmonic voltage	1
	Preparation for MCW	1
3	Elements of spectral analysis Literature: Electronic notes.	**3**
	Energy distribution in the spectrum of non-periodic non-harmonic signals	1
	Basic properties of Fourier transform. Differentiating and integrating circles	1
	Preparation for the MCW	1
4	Section 4. Processes in connected circuits.	**5**
	Determination of resonant and optimal frequencies	1
	Frequency characteristics of coupled circuits with transformer coupling	2
	Determination of the passband of a system of coupled circuits	1
	Preparation for MCW	1
5	Section 5. Elements of analog circuit synthesis	**4**
	Approximation of the frequency response using Chebyshev's theorem	1
	Element base for synthesis on OP. OP transfer coefficients. Integrating and differentiating circuits based on OP	1
	Equivalent circuits of gyrators and bicistors	1
	Preparation for MCW	1

	Total hours	**18**
6	Preparation for the exam	30
	Total hours	**48**

Policy and control

7. Academic discipline policy (educational component)

Studying the credit module requires a detailed examination of the rather complex processes that occur in electronic circuits. Successful mastery of the material is only possible with daily work on the part of the student, which consists of: taking lecture notes; studying
the content of the notes on the eve of the next lecture; detailed familiarization with the content of the methodological guidelines for the laboratory practical; careful performance of laboratory work and drawing conclusions from it that do not contradict theoretical provisions; solving calculation problems while preparing for tests.

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 conducts 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 assignments and take tests at home.

Announcement of test results

The defense of the completed section of the DCR 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 assessment is zero. If a student misses an assessment for a valid reason, they are given the opportunity to complete 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 control measures and expect that it will be considered in accordance with predefined procedures.

Students have the right to appeal the results of assessment measures, but must provide a reasoned explanation of which criteria they disagree with in accordance with the assessment sheet and/or comments.

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

A student's **rating** for a credit module consists of points awarded for:

1. Completing homework assignments for practical classes;
2. Completing the MCR (modular control work) in accordance with the topics of practical classes;
3. Completion of 4 laboratory works;
4. Completing a general test on lecture topics

Rating point system

1. **Completion of homework assignments for practical classes**

- "Excellent," complete solution with explanations (at least 90% of the required information) – 5 points;
- "good," correct solution with minor inaccuracies – 4-4.9 points
- "satisfactory," incomplete answer, correct solution (at least 60% of the required information) and minor errors – 3-3.9 points
- "unsatisfactory," unsatisfactory answer (does not meet the requirements by 3 points) – 0 points

Maximum total score for all 5 assignments – **25 points**

2. **Completion of MCRs for each topic**

- "excellent", complete solution with explanations (at least 90% of the required information) – 5 points;
- "good," correct solution with minor inaccuracies – 4-4.9 points
- "satisfactory", incomplete answer, correct solution (at least 60% of the required information) and minor errors – 3-3.9 points
- "unsatisfactory," unsatisfactory answer (does not meet the requirements by 3 points) – 0 points The

maximum number of points for all 5 MCQs is **25 points**

The maximum number of points for each topic is 5 points, and the maximum number of points for all classes is **25 points**

3. **Completion of laboratory work**

- completion of LR and preparation of a report in accordance with the requirements – 1 point; • complete answer during the defense of the lab work (at least 100%-95% of the required information) during the performance of the lab work or at the next lab session – 5 points;

- full answer during the defense of the lab report (at least 87%-75% of the required information) during the completion of the lab report or at the next lab session – 4.9-4.0 points;
- incomplete answer during the defense of the LR (at least 60% of the required information) – 3.9-3.0 points;
- unsatisfactory answer – 0 points.

The maximum number of points for each assignment is 5 points, and the total maximum number of points for all assignments is **20 points**.

4. **Completion of the general test based on the course materials**

- "excellent", complete answer (at least 90% of the required information) – 28.5-30 points;
- "Good," complete answer with minor inaccuracies – 22.5-28.49 points
- "Satisfactory," incomplete answer (at least 60% of the required information) and minor errors – 18-22.49 points
- "unsatisfactory," unsatisfactory answer (does not meet the requirements by 3 points) – 0 points.

Maximum number of points for the test – **30 points**

5. **Bonus points**

A maximum of **30 points** – for timely, complete, and correct completion of all types of tasks on each topic, points for the test are awarded automatically (the number of such students in the group should not exceed 10%).

A maximum of **30 points** – for winning prizes (first, second, third) in Olympiads in the discipline. These points can replace the 1st or 2nd point.

Conditions for a positive interim assessment

To receive a "pass" on the first interim assessment (week 8), a student must receive at least Rsem=20 points.

To receive a "pass" on the second interim assessment (week 14), the student must receive at least Rcem=40 points.

The maximum number of points is **Rcem=100**. A prerequisite for admission to the exam is the completion and defense of laboratory work. To be admitted to the exam for the credit module, you must have a rating of at least 20 points, as well as have completed all laboratory work and actively participated in classroom sessions. To receive an "automatically," you must have a rating of at least 60 points, as well as complete all laboratory work and actively attend classroom sessions.

At the end of the semester, all students who have been admitted take the exam. Points for the exam Rзал are added to the starting points Rст (Rст=0.5·Rсем, **Rст.max=50 points**), and this rating $R_Д$ ($R_Д$ = Rст+Rзал) is final.

The exam consists of three questions from different sections of the work program from the list provided in the methodological recommendations for mastering the credit module. Students who did not participate in a particular practical class receive an additional question on the topics of the practical classes. An unsatisfactory answer to the additional question lowers the overall grade by 4 points.

Each question in the test (Rtest=$R_{1Т}$ +$R_{2Р}$ +$R_{3Р}$) is graded as follows: $R_{1Т}$ =20, $R_{2Р}$ =10, $R_{3Р}$ =20 points according to the grading system.

Distribution of points:

- "excellent", complete answer (at least 95% of the required information) or correct solution to a practical task with explanations –20-18 (10-9.5) points;

- "good", complete answer (75 to 95%) or correct solution with minor inaccuracies – 15-18 (7.5-9.4);
- "satisfactory", incomplete answer or correct solution (at least 60%), which may contain some errors – 12-15 (6-7.4);
- "unsatisfactory", unsatisfactory answer, incorrect solution – 0 points.

The sum of points for each of the three questions of the exam paper Rзал and Rст is converted to a rating score for the discipline $R_д$according to the table:

Table of correspondence between rating points and grades on the university scale

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

9. Additional information on the discipline (educational component)

Questions for preparing for the exam in the discipline "Processes in Linear Electronic Circuits"

1. Obtaining circuit functions from the resistance and conductance matrix. Types of circuit functions.
2. Four-terminal circuit equivalent circuits and their equivalence (Z-parameters, Y-parameters, h-parameters, A-parameters).
3. The concept of four-terminal network feedback. Types of feedback.
4. The concept of a zero-pole map. Construction of frequency characteristics using a zero-pole map.
5. The concept of stability of circuit functions. Criteria for stability of circuit functions.
6. The concept of commutation and transient processes. Commutation laws, their proof, and consequences.
7. Laplace transform and its main properties.
8. Operator circuits for replacing reactive elements and their transformation. Ohm's and Kirchhoff's laws in operator form.
9. Finding the original. The decomposition theorem and its application to different types of roots.
10. Laplace transform and examples of Laplace function images with proof.
11. Time method of circuit analysis: concepts of impulse and transient characteristics, relationship between time characteristics. Convolution of two functions. Finding the output voltage using the Duhamel integral. Different forms of integral notation.
12. The classical method of transient process analysis. General method for calculating circuits using the classical method using the example of a series circuit, free and forced modes.
13. Commutations during a step change in current.
14. Connection of an RL circuit under constant and harmonic voltages.
15. Connection of an RC circuit to constant and harmonic voltages.
16. Transient processes in a series circuit: aperiodic, limiting, and oscillatory modes. Connection of the circuit to constant and harmonic voltages.
17. Spectral analysis of periodic non-harmonic signals: various forms of Fourier series representation. The concept of a spectral diagram.
18. Power distribution in the spectrum of periodic non-harmonic signals. The concept of power spectrum and technical spectrum width.
19. Spectral analysis of non-periodic non-harmonic signals. Forward and inverse

Fourier transforms. Spectral density function and its properties.

20. Energy distribution in the spectrum of non-periodic non-harmonic signals. Different forms of recording the inverse Fourier transform.
21. Basic properties of the Fourier transform.
22. Determination of the spectral density function of rectangular and triangular symmetric pulses.
23. Finding the response to an arbitrary action using the spectral method.
24. Integrating and differentiating circuits.
25. The concept of coupled circuits. Basic diagrams of coupled circuits and their coupling coefficients.
26. Generalized two-circuit diagram of a system of coupled circuits with transformer magnetic coupling.
27. Tuning coupled circuits. Types of resonance: first and second partial and complex, individual and complete.
28. Frequency characteristics of coupled circuits.
29. Determination of resonant and optimal frequencies.
30. Passband of coupled circuits.
31. Concept of electronic circuit synthesis. Stages of solving the synthesis problem.
32. Properties of passive two-terminal networks. Positive real Brune function.
33. Synthesis of passive two-terminal networks of input resistance and conductance according to Foster.
34. Synthesis of passive two-terminal networks according to Kauer.
35. Approximation of the transfer coefficient frequency response according to Butterworth and Chebyshev.
36. Synthesis of active analog circuits: determination of input resistance and transfer coefficient of typical circuits assembled on operational amplifiers.
37. Integrating and differentiating circuits based on operational amplifiers.
38. Hysteresis circuits and bistable circuits and their equivalent circuits.

Description of material, technical, and informational support for the discipline

Laboratory work is carried out in a specialized classroom **324-17**. There are 8 workstations equipped with measuring devices (generators, oscilloscopes, electronic voltmeters). In total, the laboratory practical is designed for 18 hours, divided into 4 laboratory works.

The working program of the academic discipline (syllabus):
Compiled by A. V. Bulashenko;
Approved by the RI Department (Minutes No. 06/2025 dated 06/24/2025)
Approved by the methodological commission of the faculty/research institute (protocol No. 06/2025 dated 25.06.2025)