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

Department of Radio Engineering

[RE-13] PROCESSES IN LINEAR ELECTRONIC CIRCUITS

Work program of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	17 - Electronics, Automation, and Electronic Communications
Specialization	172 - Electronic Communications and Radio Engineering
Educational program	All educational programs
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 18 hours, Practical classes 36 hours, Laboratory work 36 hours, Independent work 66 hours)
Semester Control/control measures	Credit
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian
Information about the course coordinator/teacher s	Lecturer: A. V. Bulashenko, Lab: A. V. Bulashenko, Independent work:A. V. Bulashenko
Course placement	https://do.ipo.kpi.ua/course/view.php?id=678

Curriculum

1. Description of the course, 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 studying all radio engineering disciplines taught later on. The goal 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:

- basic physical processes in alternating current circuits, competent use of equivalent circuits, their mathematical modeling;
- basic properties of electronic circuits and their elements at direct and alternating currents; • methods of calculating electronic circuits (traditional and modern);
- studying methods and acquiring skills in 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 engineers;
- 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**:*

GC 1 Ability to think abstractly, analyze, and synthesize

GC 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 functions 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 taught later without exception.

Knowledge and skills in the use of the following are required:

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

3. Course content

Section and topic names	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 according to section 3	1				1
Total for Section 3	**15**	**4**	**2**	**6**	**3**
Section 4. Processes in connected circuits					

1	2	3	4	5	6
Topic 4.1. Bound 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 reading

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 Polytechnic Institute, 2023. – 157 p.
2. Fundamentals of Circuit Theory: Textbook for Students of Higher Educational Institutions, Part 2 / Yu. O. Koval, L. V. Grinchenko, I. O. Milyutchenko, O. I. Rybin. SMIT Company, 2008. – 560 p.
3. Processes in Linear Electronic Circuits. Collection of Problems [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, 3.1 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 132 p.
4. Processes in Linear Electronic Circuits. Laboratory Workshop. [Electronic resource]: textbook for students majoring in 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. Processes in linear electronic circuits. Elements of synthesis. 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, 2.06 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 60 p.

10. 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.

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 Circle Theory: Textbook for Students of Higher Educational Institutions, 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 main 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 (SF), types of SF and their application. Finding SF by Y and Z matrices.
2	Frequency characteristics of circuit functions. The concept of a zero and pole map. Construction of frequency characteristics using the zero-pole map
3	Criteria for the stability of circuit functions. Mikhailov's frequency criterion. Raus-Gurvitz 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 feedback by voltage.
	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 provisions 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 connection.

	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 circuit (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 to 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 notation. 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 differentiating circuits). Spectra of some functions that are not absolutely integrated
	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. Frequency response analysis: determination resonant frequencies, study of the frequency response of current I2 when the quality factors are different
14	Passband of coupled circuits. Determination of the passband depending on the 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	Kauer synthesis by input resistance and input conductance functions (different methods of dividing polynomials).
17	Element base for active circuit synthesis: operational amplifiers, gyrators, bistable circuits, 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 tools 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)
	Lectures: 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;

2	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] MCR-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: 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] MCR-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] MCR-3	Elements of spectral analysis (deadline for writing – after Practice 6)
6	Calculation of contours with magnetic connections (deadline – Practice 7)
	Classroom assignments: 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] MCR-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 (deadline for submission – Practice 9)
	Classroom assignments: 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 for submission – 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] MCR-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 to apply the acquired knowledge in practice and to develop 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 aud. hours
1	Passive four-pole circuits	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 rating system and completing homework assignments in practical classes.

In order to better assimilate the course material, homework assignments (HA) are planned. To prepare for the HAA, students should use the recommended literature, lecture notes, and the HA guidebook. Individual assignments are given by the practical training instructor, who also sets deadlines for their completion. The HA 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 SRC
1	Section 1. Circuit function apparatus in linear circuits References: [3], [6].	**3**
	Types of feedback	1
	Methods of circuit function stability: Raus-Gurwitz method, Gurwitz method, Rausch method	1
	Preparation for MCR	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 MCR	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 MCR	1
4	Section 4. Processes in connected circuits.	**5**
	Determination of resonant and optimal frequencies	1
	Frequency characteristics of coupled circuits with transformers connection	2
	Determination of the passband of a system of coupled circuits	1
	Preparation for MCR	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 MCR	1
	Total hours	**18**

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

Policy and control

7. Policy of the academic discipline (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, consisting 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 control measures.

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 Kyiv Polytechnic Institute. 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 Home Control Work 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 for 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.

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. Completion of 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 Module Control Works 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

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

Maximum number of points for each topic – 5 points, maximum number of points for all classes – **25 points**

3. Completion of laboratory work

- completion of the lab report and its formatting in accordance with the requirements – 1 point; • complete answer at the LR defense (at least 100%-95% of the required information) during the LR or at the next laboratory class – 5 points;

- complete answer at the LR defense (at least 87%-75% of the required information) during the LR or at the next laboratory session – 4.9-4.0 points;
- incomplete answer during the LR defense (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, the total maximum number of points for all assignments is **20 points**.

4. Completion of the General Test based on 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.

The maximum number of points for the test is **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** can be awarded for winning prizes (first, second, third) in subject Olympiads. These points can replace points 1 or 2.

Conditions for a positive interim assessment

To receive a "pass" on the first interim assessment (week 8), the 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 Rsem=40 points.

The maximum number of points is **Rsem=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 activities. To receive a grade
To qualify automatically, students must have a grade of at least 60 points, complete all laboratory work, and actively attend classroom sessions.

At the end of the semester, all eligible students take a test. Points for the test (Rtest) are added to the starting points (Rst = 0.5·Rсем, **Rst.max = 50 points**), and this rating (R_d= Rst+Rsem) 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 of the final assignment (Rhall=R_{1T} +R_{2P} +R_{3P}) is evaluated as follows: R_{1T} =20, R_{2P} =10, R_{3P} =20 points in accordance with the evaluation 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 Rtest and Rst is converted to a rating score for the discipline R_d 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
Conditions for admission not met	Not admitted

6. 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 transform of functions 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 under constant and harmonic voltages.
16. Transient processes in a series circuit: aperiodic, limiting, and oscillatory modes. Connection of a circuit under 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 transform. 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 resonances: 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 conductivity according to Foster.
34. Synthesis of passive two-pole networks according to Kauer.
35. Approximation of the frequency response of the transfer coefficient according to Butterworth and Chebyshev.
36. Synthesis of active analog circuits: determination of input impedance and transfer coefficient of typical circuits assembled on operational amplifiers.
37. Integrating and differentiating circuits based on operational amplifiers.
38. Hysteresis and bistable circuits and their equivalent circuits.

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

Laboratory work is carried out in a specialized classroom **324-17**. There are 8 workstations with measuring devices (generators, oscilloscopes, electronic voltmeters). In total, the laboratory workshop 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. 06/2024 dated 06/27/2024)
Approved by the methodological commission of the faculty/research institute (protocol No. 06/2024 dated 28.06.2024)