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

Electronic Engineering Department

ANALOGUE AND DIGITAL CIRCUITS DESIGN-1. ANALOG CIRCUIT DESIGN

Syllabus

Details of the discipline	
Level of higher education	*First (bachelor's)*
Field of knowledge	*16 Chemical and bioengineering*
Specialty	*163 Biomedical Engineering*
Educational program	*Medical Engineering*
Status of the discipline	*Normative*
Form of study	*Full-time*
Year of study, semester	*3 course, autumn semester*
Volume of discipline	*4,5 credits (135 hours)*
Semester control	*exam*
Schedule	*lectures, practical and laboratory classes, http://rozklad.kpi.ua/*
Language	*English*
Information about course leader	*Ph.D., Associate Professor, Porieva Hanna Sergeevna, porevanna-ee@lll.kpi.ua*
Placement of the course	Google classroom, electronic campus KPI. Igor Sikorsky (https://login.kpi.ua)

Curriculum of the discipline

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

Credit module "Analog and digital circuit design-1. Analog Circuit Design " (hereinafter -" AS ") is an integral part of the normative discipline" Electrical Engineering and Electronics "in the cycle of professional training.

The credit module "AS" is an important component in the bachelor's program and basic for the study of other disciplines.

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

- analysis of analog circuits;

- development of analog circuits of functional units and electronic devices.

According to the requirements of the curriculum, students after mastering the credit module must demonstrate the following learning outcomes:

knowledge:

- functional and technical characteristics of the modern element base;

- typical schemes of common functional modules.

skills:

- selection of the element base in accordance with the problem to be solved;

- mathematical modeling of analog circuits;

- determination of time, frequency characteristics of circuits;

- definition of circuit functions;

- use of computer-aided design tools;

- diagnostics of electronic circuits.

experience:

- modeling of analog and digital circuits and evaluation of its results;

- design of functional components of electronics;

- application of computer-aided design tools.

***The programme competencies** obtained by students after passing the discipline are:*

***General competencies** (The programme was put into effect by the Rector's Order № NON/89/2021 from 19.04.2021):*

***GC 1** – Ability to apply knowledge in practical situations.*

***GC 2** – Knowledge and understanding of the subject area and understanding of professional activity.*

***Special (professional) competencies** (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):*

***PC 1** – Ability to use engineering software packages for research, analysis, processing and presentation of results, as well as for automated design of medical devices and systems.*

***PC 3** – Ability to study and apply new methods and tools for analysis, modeling, design and optimization of medical devices and systems.*

***PC 6** – Ability to effectively use tools and methods for analysis, design, calculation and testing in the development of biomedical products and services.*

***The programme learning outcomes** (The programme was put into effect by the Order of the Rector № NON/89/2021 from 19.04.2021):*

***PLO 8** – Understand theoretical and practical approaches to the creation and management of medical equipment and medical equipment.*

***PLO 13** – Be able to analyses the signals transmitted from the organs to the devices, and to process diagnostic information (signals and images).*

***PLO 14** – Be able to analyses the level of compliance with modern world standards, as well as evaluate solutions and tasks for the development of automated control systems, taking into account the capabilities of modern hardware and software automation of medical equipment.*

***PLO 16** – Be able to use automated design and engineering systems to develop a technological and hardware scheme of medical devices and systems, taking into account the peculiarities of their components.*

***PLO 18** – Understanding of fundamental-applied, medical-physical, physico-chemical laws of functioning of biological objects, and bioengineering bases of technologies and equipment for research of processes of a human body.*

PLO 19 *– Possession of engineering methods of calculation of elements of devices and systems of medical appointment and a choice of classical and newest constructional materials, and also means of designing of devices, devices and systems of medico-biological appointment.*

PLO 20 *– Knowledge and application of research methods in biomedical engineering, methods and tools for organizing and processing experimental data, statistical methods for modeling and simulating processes and systems of physical and biological nature, modern programming technologies and supporting tools, methods for designing digital and microprocessor-based medical systems.*

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)

The study of the credit module "AC" is based on knowledge, skills and experience gained during the study of disciplines "Electrical Engineering and Electronics", "Fundamentals of Discrete Mathematics" and "Signal Theory" in the sections of continuous signal processing.

The acquired knowledge, skills and experience are the basis for the study of credit modules "Analog and digital circuitry-1. Digital Circuitry ", which relies on the acquired knowledge on the analysis of the basic elements of digital devices, and" Biomedical devices, apparatus and complexes ".

3. The content of the discipline

A list of sections and topics of the whole discipline is provided.

1. Basic elements of analog circuitry. Amplifiers of electrical signals

1.1. Basic elements of analog circuitry. Passive bipolar and multipole components.

1.2. Amplifiers of electrical signals. Basic definitions. Classification, main indicators of amplifiers. Schemes for providing static mode of bipolar and field-effect transistor.

1.3. Amplifiers with common emitter (CE), with common base (CB), with common collector (CC) in the field of small times and high and medium frequencies. Amplifiers with a common source (CS), with a common gate (CG), with a common drain (CD) in the region of low times and high and medium frequencies.

1.4. Power amplifiers. Matching the signal source with the load. Single-stroke power amplifiers. Two-stroke transformer power amplifiers. Power amplifiers without transformers.

2. Amplifier feedback

2.1. General concepts and classification of feedback. Influence of feedback on amplification and its instability. The effect of feedback on the input and output of the amplifier.

2.2. The effect of feedback on the lower, upper cutoff frequencies and bandwidth of the amplifier. Stability of feedback amplifiers.

2.3. Broadband amplifiers. Conditions for signal transmission by the amplifier without distortion. High-frequency and low-frequency correction of RC-amplifier with frequency-dependent load. High frequency and low frequency correction of RC amplifier with negative feedback.

3. High-precision electrical signal converters. Linear and nonlinear functional converters

3.1. General characteristics and classification of operational amplifiers. Macromodels of operational amplifiers

3.2. Large-scale inverting and non-inverting amplifiers. Differential amplifier. Adders. Impedance inverter.

3.3. Differentiators, integrators, phase shifters.

3.4. Logarithm and antilogarithm schemes. AC voltage modules. Voltage multipliers and dividers. Devices that perform mathematical operations.

3.5. Reference voltage sources. Stable current generators.

3.6. Voltage level transmitters. Voltage-current, current-voltage converters.

4. Frequency filters

4.1. Parallel and serial LC circuits. RC Bridge Wine. Double RC bridge. LC amplifier on a bipolar (field) transistor.

4.2. Active woofer and RF filters of the first and second order. Secondary bandpass and bandpass filters are active.

5. Generators of harmonic oscillations.

5.1. Conditions for the generation of harmonic oscillations. RC generators with zero phase shifter. RC-generators with double T-bridge.

5.2. Conditions for generating harmonic oscillations in three-point LC-generators. LC generators with inductive three-point in circuits with common emitter (CE) and common base (CB) (with common source (CS) and common gate (CG). LC-generators with capacitive three-point in circuits CE and CB (CS and CG).

6. Radio frequency converters

6.1. Modulators and demodulators of AM signals

6.2. Modulators and demodulators of FM signals

7. Pulse devices

7.1. Pulse shapers. Schmitt's trigger

7.2. Relaxation generators (multi- and single-vibrators)

8. Power supplies

8.1. General structure of the secondary power supply. Rectifiers. Smoothing filters.

8.2. Linear stabilizers

8.3. Pulse stabilizers and converters

4. Training materials and resources

Basic literature:

1. *Піддубний В. О., Товкач І. О. Елементна база радіоелектронної апаратури. В 4 ч. Ч. 1: Пасивні радіокомпоненти. Київ : КПІ ім Ігоря Сікорського, 2021. 98 с.*
2. *Піддубний В. О., Товкач І. О. Елементна база радіоелектронної апаратури. В 4 ч. Ч. 2: Напівпровідники та діоди. Київ : КПІ ім Ігоря Сікорського, 2021. 117 с.*
3. *Піддубний В. О., Товкач І. О. Елементна база радіоелектронної апаратури. В 4 ч. Ч. 3: Багатоперехідні структури. Київ : КПІ ім Ігоря Сікорського, 2021. 134 с.*
4. *Елементна база електронних апаратів : навчальний посібник. Ч. 1: Фізичні основи електронної техніки / М. А. Філинюк, О. О. Лазарєв, О. В. Войцеховська [та ін.]. Вінниця : ВНТУ, 2015. 100 с.*

5. *Аналогова схемотехніка та імпульсні пристрої: підручник / В. І. Бойко, В. Я. Жуйков, А. А. Зорі та ін. 3-е вид., доповн. і переробл. К.: Освіта України, 2012. 480 с.*

6. *Сєдов С. О. Оброблення сигналів на базі операційних підсилювачів. Схемотехніка. Розрахунки : навчальний посібник. К.: КПІ ім. Ігоря Сікорського, 2018. 132 с.*

7. *Медяний Л. П. Аналогова схемотехніка. К. : КПІ ім. Ігоря Сікорського, 2017. 177 с.*

8. *Елементна база радіоелектронної апаратури та телекомунікаційних систем : лабораторний практикум / М. А. Філинюк, О. О. Лазарєв, О. В. Войцеховська, О. Л. Пастушенко. Вінниця : ВНТУ, 2017. 90 с.*

9. *Методичні вказівки до курсового проектування з курсів "Основи електроніки" та "Аналогова схемотехніка": для студентів спец. 152 "Метрологія та інформаційно-вимірювальна техніка" / уклад. : І. В. Григоренко, М. В. Трохін; Нац. техн. ун-т "Харків. політехн. ін-т". – Харків: НТУ "ХПІ", 2019. – 34 с.*

Additional literature:

1. *Елементна база електронних апаратів : навчальний посібник. Ч. ІІІ: Напівпровідникові діоди та тиристори / М. А. Філинюк, О. О. Лазарєв, О. В. Войцеховська [та ін.]. Вінниця : ВНТУ, 2016. 92 с.*

2. *Стахів П. Г., Коруд В. І., Гамола О. Є. Основи електроніки: функціональні елементи та їх застосування. Львів : Магнолія, 2015. 206 с.*

3. *Основи схемотехніки. Аналогова та інтегральна схемотехніка : навчальний посібник / В. М. Кичак, В. Д. Рудик, А. О. Семенов, О. О. Семенова. Вінниця: ВНТУ, 2013. 267 с.*

4. *Електроніка та мікросхемотехніка : підручник / О. М. Воробйова, І. П. Панфілов, М. П. Савицька, Ю. В. Флейта. Одеса : ОНАЗ ім. О. С. Попова, 2015. 298 с.*

5. *Зубчук В.І., Попов А.А., Фесечко В.А. Комп'ютерна схемотехніка:Методичні вказівки до курсового проектування для студентів напрямків 6.050101 – "Комп'ютерні науки", 6.051003 - "Приладобудування". НМУ № Е9/10-225, 18.03.2010 р.*

6. *Матвійків М. Д., Когут В. М., Матвійків О. М. Елементна база електронних апаратів: підручник. 2-ге вид. Львів : НУ "Львівська політехніка", 2007. 428 с.*

7. *Схемотехніка електронних систем: У 3 кн. Кн. 1. Аналогова схемотехніка та імпульсні пристрої: Підручник / В. І. Бойко, А. М. Гуржій, В. Я. Жуйков та ін. — 2-ге вид., допов. і переробл. — К.: Вища шк., 2004. — 366 с.: іл.*

8. *Фесечко В.О., Зубчук В.І., Попов А.О. Методичні вказівки до курсового проектування по схемотехніці. – Київ: КПІ, 2009. – 130 с.*

9. *Схемотехніка електронних систем : у 3 кн. Кн. 1. Аналогова схемотехніка та імпульсні пристрої : підручник / В. І. Бойко, А. М. Гуржій, В. Я. Жуйков та ін. 2- ге вид., допов. і переробл. К. : Вища школа, 2004. 336 с.*

Educational content

5. Methods of mastering the discipline (educational component)

The lecture part is devoted to the presentation of methods of analysis and synthesis of analog electronic circuits in accordance with the functional classification of sections of the course, and in particular the presentation of functional and technical characteristics of modern elements, construction and analysis of typical circuits of common functional modules.

№	***The title of the lecture topic and a list of key issues (list of didactic tools, references to literature and tasks for independent work of students)***
1.	*Topic 1.1. Basic elements of analog circuitry. Passive bipolar and multipole components.* *Literature: basic 1-6.* *Tasks for independent work: Matrix method of calculation of circuit functions. Parameters and characteristics of bipolar and field-effect transistors.*
2.	*Topic 1.2. Amplifiers of electrical signals. Basic definitions. Classification, main indicators of amplifiers. Schemes for providing static mode of bipolar and field-effect transistor.* *Topic 1.3. Amplifiers with common emitter (CE), with common base (CB), with common collector (CC) in the field of small times and high and medium frequencies. Amplifiers with a common source (CS), with a common gate (CG), with a common drain (CD) in the region of low times and high and medium frequencies.* *Literature: basic 1-6.* *Tasks for independent work: Calculation of circuit functions for amplifier stages with CE, CB, CC.*
3.	Topic 1.2. Amplifiers of electrical signals. Basic definitions. Classification, main indicators of amplifiers. Schemes for providing static mode of bipolar and field-effect transistor. Topic 1.3. Amplifiers with common emitter (CE), with common base (CB), with common collector (CC) in the field of small times and high and medium frequencies. Amplifiers with a common source (CS), with a common gate (CG), with a common drain (CD) in the region of low times and high and medium frequencies. Literature: basic 1-6. Tasks for independent work: Calculation of circuit functions for amplifier stages with CS, CG, CD.
4.	Topic 1.4. Power amplifiers. Matching the signal source with the load. Single-stroke power amplifiers. Two-stroke transformer power amplifiers. Power amplifiers without transformers. Literature: basic 1-5. Tasks for independent work: Folded transistor, Darlington circuit. Classes of power amplifiers.
5.	Topic 2.1 General concepts and classification of feedback. Influence of feedback on amplification and its instability. Influence of feedback on the input and output supports of the amplifier. Literature: basic 1-5. Tasks for independent work: Obtaining analytical expressions of circuit functions for a cascade that is covered by feedback.
6.	Topic 2.2. The effect of feedback on the lower, upper cutoff frequencies and bandwidth of the amplifier. Stability of feedback amplifiers. Literature: basic 1-5. Tasks for independent work: Obtaining analytical expressions of the stability of the cascade covered.

7.	Topic 2.3. Broadband amplifiers. Conditions for signal transmission by the amplifier without distortion. High-frequency and low-frequency correction of RC-amplifier with frequency-dependent load. High frequency and low frequency correction of RC amplifier with negative feedback. Literature: basic 1-5. Tasks for independent work: Calculation of circuit functions for amplifier with low-frequency and high-frequency correction.
8.	Topic 3.1. General characteristics and classification of operational amplifiers. Macromodels of operational amplifiers Topic 3.2. Large-scale inverting and non-inverting amplifiers. Differential amplifier. Adders. Impedance inverter. Literature: basic 1-4, 7-8. Tasks for independent work: Parameters and nomenclature of modern operational amplifiers.
9.	Topic 3.3. Differentiators, integrators, phase shifters. Literature: basic 1-8. Tasks for independent work: Integrator reset schemes. Stability analysis of integrators and phase shifters.
10.	Topic 3.4 Logarithm and antilogarithm schemes. Module shapers alternating voltage. Voltage multipliers and dividers. Devices that perform mathematical operations Literature: basic 1-8. Tasks for independent work: History of development and application of analog computers.
11.	Topic 3.5 Reference voltage sources. Stable current generators. Voltage level transmitters. Voltage-current, current-voltage converters. Literature: basic 1-6. Tasks for independent work: Integrated sources of reference voltage, their characteristics.
12.	Topic 4.1. Parallel and serial LC circuits. RC Bridge Wine. Double RC bridge. LC amplifier on a bipolar (field) transistor. Literature: basic 1-3. Tasks for independent work: Obtaining analytical expressions for circuit functions of a transistor LC-amplifier.
13.	Topic 4.2. Active woofer and RF filters of the first and second order. Secondary bandpass and bandpass filters are active. Literature: basic 1-8. Tasks for independent work: Types of filter frequency response approximation. Means of

	automated synthesis and analysis of frequency filters.
14.	Topic 5.1. Conditions for the generation of harmonic oscillations. RC generators with zero phase shifter. RC-generators with double T-bridge. Literature: basic 1-4. Tasks for independent work: Calculation of schemes of RC-generators of harmonic oscillations.
15.	Topic 5.2. Conditions for generating harmonic oscillations in three-point LC-generators. LC generators with inductive three-point in circuits with common emitter (CE) and common base (CB) (with common source (CS) and common gate (CG). LC-generators with capacitive three-point in circuits CE and CB (CS and CG) Literature: basic 1-4. Tasks for independent work: Calculation of schemes of LC-generators of harmonic oscillations.
16.	Topic 8.1. General structure of the secondary power source. Rectifiers. Smoothing filters. Literature: basic 10-11. Tasks for independent work: Nomenclature of modern element base for secondary power supplies.
17.	Topic 8.2. Linear stabilizers Literature: basic 9.10. Tasks for independent work: Modern integrated linear stabilizers and their characteristics.
18.	Topic 8.3 Pulse stabilizers and converters Literature: basic 9.10. Tasks for independent work: Modern integrated controllers of pulse voltage converters. Means of the automated search and calculation of schemes of power converters

Practical classes are designed to consolidate the theoretical material, which is considered in lectures and in the course of independent work. In practical classes, the current survey of students is performed, as well as two parts of the modul test.

№	***Name of the topic of the lesson and a list of main questions (list of didactic support, references to literature and tasks for independent work of students)***
1.	*Schemes of providing the static mode in amplifiers in the schemes CE, CB, CC and CS, CG, CD.*
2.	*Decomposition a large diagram into subcircuits. Macromodels of electronic circuit.*
3.	*Feedback in field amplifiers and bipolar transistors. High frequency correction in RC amplifiers.*
4.	Basic circuits on the operational amplifier.
5.	*Synthesis of active second-order filters.*
6.	*RC-generator with Wine bridge. LC-generators with inductive and capacitive three-point.*

№	Name of the topic of the lesson and a list of main questions (list of didactic support, references to literature and tasks for independent work of students)
7.	*Logarithmization and antilogarithmization schemes.*
8.	*Multipliers and voltage dividers.*
9.	*Power sources.*

Laboratory works are designed to acquire practical skills in working with real electronic digital circuits, the use of measuring equipment to study the layout of analog circuits, the use of computer tools for modeling the operation of analog components and electronic circuits composed of them.

№	Name of laboratory work	Number of hours
1.	*Amplifiers on bipolar transistors*	*4*
2.	*Amplifier feedback*	*4*
3.	*Zero order operating links*	*4*
4.	*Active RC filters*	*6*
Total		*18*

6. Independent student work

The student's independent work includes the study of topics that are sufficiently covered in the literature and the implementation of individual tasks.

№	The name of the topic that is submitted for independent study	Number of hours
1.	*Calculation and graphic work synthesis of active filters on OP.*	*12*
2.	*Modulators and demodulators of AM signals*	*4*
3.	*Modulators and demodulators of FM signals*	*4*
4.	*Pulse shapers. Schmitt's trigger*	*4*
5.	*Relaxation generators (multi- and single-vibrators)*	*6*

Individual written tasks are performed in the form of calculation and graphic work. The purpose of computational and graphic work is the formation of skills and experience in the synthesis of active analog filters on operational amplifiers, the application of theoretical knowledge in solving practical problems, mastering the skills of determining time, frequency characteristics of circuits, defining circuit functions, choosing element base according to problem solving , mathematical modeling of analog circuits, the use of automated design tools for practical calculations, evaluation and analysis of the results. As a result of performing calculation and graphic work, the knowledge and skills acquired in lectures and practical classes are also tested.

Policy and control

7. Policy of academic discipline (educational component)

● *Attendance at lectures, practical and laboratory classes is mandatory. In the case of distance learning, points are accrued for attending classes, which are taken into account in the student's rating.*

● *Reports on laboratory work and individual tasks (calculation and graphic work) are handwritten.*

● *For late completion of tasks, penalty points are implied.*

8. Types of control and rating system for grading learning outcomes (RSG)

A student's credit module rating consists of the points he receives for:

1) Two parts of modular control work;

2) Performance of all laboratory works;

3) Performance of calculation and graphic work.

Rating points system:

1. Modular control work

The purpose of control works is to check the mastery of the basic theoretical principles of the discipline, practical skills of applying theoretical knowledge in solving practical problems, to check the mastery of educational material, which was made for independent study.

Topics submitted for control work require additional study during independent work. The purpose of the control work is to check the quality of VTS performance and consolidate the acquired skills

It consists of two parts on the following topics:

- calculation and synthesis of transistor amplifier stages. Feedback in transistor amplifiers;

- calculation and synthesis of circuits on operational amplifiers.

Test work is performed by each student independently on an individual basis.

Each part of the modular test is performed in the form of a written answer to one theoretical question and the solution of the problem of analysis of the proposed scheme. The maximum score for the part of the module control work (MCW) is 15 points (5 points for the correct answer to the theoretical question + 10 points for the correct solution of the problem), which is 20% of the final rating. The maximum score for the MCW is 2 parts x 20 points = 30 points, which is 30% of the final rating.

Evaluation criteria:

- the maximum score for the answer to the theoretical question is set in the case of full and correct disclosure of the essence of the question, giving complete and equivalent schemes, analytical expressions for calculation, indicating the way to obtain them;

- the score for the answer to the theoretical question is reduced if there are shortcomings in the answer;

- the maximum score for solving the problem is set in the case of correctness of analytical expressions of the required circuit functions depending on the denominations of components and parameters of macromodels.

2. Laboratory works

During the study of the course "Analog and digital circuit design-1. Analog Circuit Design" students perform 4 laboratory works.

Each of the first three laboratory works based on the results of the defense is evaluated according to the system with a maximum score of 5, which is 5% of the final rating.

Evaluation criteria:

- the maximum score is given for laboratory work performed on time and in accordance with the work task, if the correct results are obtained, neatly executed report, correctly formulated conclusions to the work, defense demonstrates understanding of all results and stages of their receipt, fluency in theoretical work;

- laboratory work is evaluated in 4 points, if there are minor shortcomings in the performance of work, the results obtained, the report, the conclusions drawn and the defense of the work;

- laboratory work is evaluated in 3 points, if there are significant shortcomings in the performance of work, the results obtained, the report, the conclusions made and the defense of the work;

- laboratory work is evaluated in 2 points, if there are significant shortcomings in the performance of work, the results obtained, the report, the conclusions drawn and the defense of the work;

3. Performance of calculation-graphic work

During the study of the course "Analog and digital circuit design-1. Analog Circuit Design" students perform calculation-graphic work (CGW)" Synthesis of active filters ", which involves the synthesis and development of the circuit of the basic electrical functional unit of analog signal processing with the analysis of the developed solution.

Calculation-graphic work is performed within the time limits set by the teacher. CGW is considered to be performed correctly if all tasks are performed completely, in accordance with the task, the appropriate methods are used and the correct results are obtained according to the specification for the synthesis of the active filter. The maximum score for RGR passed and defended on time is 30 points, which is 30% of the final semester rating.

All tasks of calculation and graphic work are mandatory. For each CGW task not passed at the time of calculating the final rating, the rating is reduced by the appropriate number of points.

The procedure for converting the rating into a final

Rating is a quantitative measure of the knowledge and skills of students acquired during the study of the discipline. Based on the RD rating scored, a final grade is given.

The rating is typed based on the results:

- *Execution of practical tasks;*
- *Performing laboratory work;*
- *Execution of modular control works (MCW);*
- *Execution and protection of Calculation-graphic work (CGW);*
- *Passing a written exam.*

During the semester practical tasks are performed, 4 laboratory works, 1 MCW (part 1 and part 2), CGW.

Task type	Number of tasks	Assessment scale (highest score)
Practical tasks	2	10
Laboratory works	4	5
MCW	1	30
Theoretical question	2	5
Practical question	2	10
CGW	1	30

The result of the semester rating is formed in accordance with the terms of intermediate certifications. Thus, the maximum rating for all types of work during the semester is Rsem = 2 × 10 + 4 × 5 + 30 + 30 = 100 points.

The exam is conducted on tickets with 2 theoretical and 1 practical task. Theoretical tasks are evaluated on a thirty-point scale, practical tasks on a forty-point scale. Thus, the maximum rating based on the results of the test is Rex = 2 × 30 + 40 = 100 points.

The maximum rating based on the results of the semester and the performance of examination work is RD = Rsem × 0.5 + Rex × 0.5 = 50 + 50 = 100 points.

Estimates are determined according to the table:

Rating value from credit RD module	Grade and its definition
0,95R ≥ RD	Perfectly
0,85R ≥ RD > 0,95R	Very good
0,75R ≥ RD > 0,85R	Good
0,65R ≥ RD > 0,75R	Satisfactorily
0,6R ≥ RD > 0,65R	Enough (meets minimum criteria)
RD < 0,95R	Unsatisfactorily

Conditions for positive intermediate certification

Calendar attestation of students (for 8 and 14 weeks of semesters) in disciplines is carried out by teachers according to the value of the current rating of the student at the time of attestation. If the value of this rating is not less than 50% of the maximum possible at the time of certification, the student is considered satisfactorily certified. Otherwise, in the attestation statement is set "unsatisfactory".

7. Additional information on the discipline (educational component)

Certificates of distance or online courses on the subject can be credited subject to the requirements set out in the ORDER № 7-177 FROM 01.10.2020 R. "On approval of the provisions on recognition in the KPI. Igor Sikorsky learning outcomes acquired in non-formal / informal education»

An indicative list of theoretical questions to be taken in the examination is given in ***Annex 1****.*

Syllabus:

Compiled *by Associate Professor of Electronic Engineering, Ph.D., Porieva Hanna Sergeevna.*

Approved *by the Department of Biomedical Engineering (protocol № 16 of June 21, 2024)*

Approved *by the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 9 of June 26, 2024)*

Annex 1.

Approximate list of exam questions of the course

1. Static mode of RC-amplifier in the circuit of CE (p-n-p and n-p-n transistors).
2. Static mode of the RC-amplifier in the circuit of CB.
3. Static mode of the RC amplifier in the circuit of CC.
4. Static mode of RC-amplifier in the circuit of CS (with p and n-channel).
5. Static mode of the RC amplifier in the circuit of CG.
6. Static mode of the RC-amplifier in the circuit of CD.
7. Scheme of providing static mode in RC-amplifiers on bipolar transistors.
8. Scheme of providing static mode in RC-amplifiers on field-effect transistors.
9. RC-amplifier in the CE circuit for the midrange.
10. RC-amplifier in the CB circuit for the midrange.
11. RC-amplifier in the CC circuit for the midrange.
12. RC amplifier in the CS circuit for the midrange.
13. RC-amplifier in the CG circuit for the midrange.
14. RC amplifier in the CD circuit for the midrange.
15. Macromodel of RC amplifier at medium frequencies. Comparison of RC-amplifier functions CE, CB, CC at medium frequencies.
16. RC amplifier in the CE circuit for the low frequency band (high times).
17. RC-amplifier in the CB circuit for the low frequency band (high times).
18. RC-amplifier in the CC circuit for the low frequency band (high times).
19. RC amplifier in the CS circuit for low frequency band (high times).
20. RC-amplifier in the CG circuit for the low frequency band (high times).
21. RC amplifier in the CD circuit for the low frequency band (high times).
22. Macromodel of RC-amplifier at low frequencies. Comparative analysis of time and frequency characteristics and parameters of RC-amplifier CE, CB, CC at low frequencies.
23. RC-amplifier in the CE circuit for the high frequency band (low times).
24. RC-amplifier in the CB circuit for the high frequency band (low times).
25. RC-amplifier in the CC circuit for the high frequency band (low times).
26. RC-amplifier in the CS circuit for the high frequency band (low times).
27. RC-amplifier in the CG circuit for the high frequency band (low times).
28. RC-amplifier in the CD circuit for the high frequency band (low times).
29. Macromodel of RC amplifier at high frequencies. Comparative analysis of time and frequency characteristics and parameters of RC-amplifier functions CE, CB, CC at high frequencies.
30. Complete macromodel of RC-amplifier. Time and frequency characteristics of RC-amplifier CE, CB, CC in a wide range of frequencies (times)
31. HF-correction of RC-amplifier in the scheme with CE by means of frequency-dependent loading.

32. HF correction of the RC amplifier on a bipolar transistor using frequency-dependent negative current feedback.

33. HF correction of the RC amplifier on the field-effect transistor using frequency-dependent negative current feedback.

34. HF correction of the RC amplifier on a bipolar transistor using frequency-dependent negative voltage feedback.

35. HF correction of the RC amplifier on the field-effect transistor using frequency-dependent negative voltage feedback.

36. HF correction of the RC amplifier on a bipolar transistor using frequency-dependent negative current feedback.

37. HF correction of RC amplifier on a field-effect transistor using frequency-dependent negative current feedback.

38. HF correction of RC amplifier on bipolar transistor using frequency-dependent load.

39. HF-correction of RC-amplifier on the field-effect transistor using frequency-dependent load.

40. Broadband RC amplifier on a bipolar transistor. Transmission condition without distortion.

41. Broadband RC amplifier on a field-effect transistor. Condition of signal transmission without distortion.

42. Multiband RC amplifier.

43. Sources of reference voltage as an element of IC.

44. Stable current generator as an element of IC.

45. Voltage level translator as an IC element.

46. Differential amplifier as an element of IC.

47. Power amplifiers as an element of IC.

48. Schematic electrical principle OA LM324.

49. Large-scale amplifiers on the OA.

50. Differential scale amplifier on the OA.

51. Summing amplifier on the OA.

52. Impedance inverter on the OA.

53. Converter of controlled current and voltage sources on the OA.

54. Differential amplifiers on the OA.

55. Integrating amplifiers on the OA.

56. Phase-rotating amplifiers on OA.

57. General characteristics of active filters.

58. Active LF and HF filters of the first order.

59. Active low-pass and high-pass filters of the second order.

60. Band-pass filters of the second order.

61. Band-pass filters of the second order.

62. Conditions for the generation of harmonic oscillations.

63. PC-generators with phase return in the feedback circuit.
64. PC-generators without phase turn in the feedback circuit (with Vina bridge, 2T-bridge).
65. LC-generators with transformer feedback.
66. General characteristics of three-point circuits of the LC-generator.
67. LC-generator with an inductive three-point in the CE circuit.
68. LC-generator with an inductive three-point in the CB scheme.
69. LC-generator with an inductive three-point in the CS circuit.
70. LC-generator with an inductive three-point in the circuit CG.
71. LC-generator with a capacitive three-point in the CE circuit.
72. LC-generator with a capacitive three-point in the CB scheme.
73. LC-generator with a capacitive three-point in the CS circuit.
74. LC-generator with a capacitive three-point in the circuit CG.
75. LC-generator on the tunnel diode.
76. Frequency stabilization in harmonic oscillation generators (quartz resonator).
77. Quartz LC-generator with inductive three-point.
78. Quartz LC-generator with capacitive three-point.
79. General characteristics of nonlinear functional converters on OA.
80. Logarithmic amplifiers on the OA.
81. Anti-logarithmic amplifiers on the OA.
82. Multipliers of analog signals.
83. Devices of elevation to degree n of analog signals.
84. Divider of analog signals.
85. Devices of the product of the root of the degree of n analog signals.
86. Diode limiters of the signal level from above.
87. Diode limiters of the signal level from below.
88. Mutual signal limiters.
89. Detectors of electrical signals.