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

Department of Applied Radio Electronics

[RE-342] DESIGN OF INTELLIGENT RADIO ELECTRONIC SYSTEMS COMPONENTS

Curriculum of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	G Engineering, Manufacturing and Construction
Specialization	G5 Electronics, Electronic Communications, Instrument Engineering and Radio Engineering
Educational program	Intelligent technologies of radio electronics
Discipline status	Regulatory
Form of higher education	Full-time
Year of training, semester	3rd year, fall semester
Scope of the discipline	6 credits (Lectures 46 hours, Practical work 30 hours, Laboratory work 14 hours, Independent work 90 hours)
Semester control/control measures	Exam
Class schedule	https://rozklad.kpi.ua
Language of instruction	Ukrainian
Information about the course coordinator/teachers	Lecturer: V. O. Adamenko, Lab: I. M. Kyrpatenko,
Course location	

Course program

1. *Description of the course, its purpose, subject matter, and learning outcomes*

Design of Intelligent Radio-Electronic System Components is a compulsory component of the professional training cycle under the educational program "Intelligent Radio-Electronic Technology."

Design of Intelligent Radio-Electronic System Components is devoted to the study of:

- basic concepts of operational amplifiers, their internal circuitry, characteristics, and areas of application, ranging from elementary circuits of inverting and non-inverting amplifiers and summers to various active filters.
- the specifics of designing complex electronic devices that use modern digital solutions (digital microcircuits, DACs, ADCs, drivers, etc.) and digital data transmission protocols such as SPI, I2C, UART, CAN, etc.

The purpose of studying this discipline is:

- the use of operational amplifiers in circuit solutions used in the construction of radio-electronic devices and systems (the main task is to select the appropriate type of OP).
- Acquiring skills in circuit design and testing;
- Acquiring skills in selecting the optimal method of data transmission between digital circuits;
- Acquiring skills in modeling electronic circuits and their parts using modern computer modeling tools based on Spice models.

The discipline develops the following competencies in accordance with the OP:

General competencies:

GC01: Ability to think abstractly, analyze, and synthesize
GC02: Ability to apply knowledge in practical situations
GC04: Knowledge and understanding of the subject area and understanding of professional activities
GC05: Ability to communicate in the state language both orally and in writing
GC07: Ability to learn and acquire modern knowledge
GC08: Ability to identify, pose, and solve problems

Professional competencies:

PC01: Ability to understand the essence and significance of information in the development of a modern information society
PC02: Ability to solve standard tasks of professional activity based on information and bibliographic culture using information and communication technologies and taking into account the basic requirements of information security
PC03: Ability to use basic methods, means, and tools for obtaining, transmitting, processing, and storing information
PC04: Ability to perform computer modeling of devices, systems, and processes using universal application software packages
PC06: Ability to perform instrumental measurements in information and telecommunications networks, telecommunications and radio engineering systems
PC08: Willingness to promote the implementation of promising technologies and standards
PC09: Ability to accept and master new equipment in accordance with current standards
PC10: Ability to install, debug, configure, adjust, test, and commission telecommunications and radio engineering structures, facilities, and equipment
PC12: Ability to perform work related to managing the load flows of information and telecommunications networks
PC16: Ability to apply standard calculation methods in the design of telecommunications and radio engineering devices and systems
PC18: Ability to assess the place and advantages of introducing elements of intelligent technologies and intelligent radio electronics into various fields of human activity

PC20: Ability to select methods and means of information processing using intelligent technologies
PC22: Ability to select and critically evaluate and choose technical solutions at all stages of development and design of radio-electronic equipment using intelligent technologies
PC23: Ability to select and apply specialized software tools for simulation modeling and design of radio-electronic equipment
PC25: Ability to reasonably select CAD software for analysis, calculation, optimization of the output characteristics of mathematical and circuit models of analog and digital devices depending on the frequency range, taking into account external factors, use Internet information resources to obtain mathematical and design models of radio components from manufacturers based on an assessment of the characteristics of information transmission in radio networks

Program learning outcomes:

PLO01: Analyze and make informed decisions when solving specialized tasks and practical problems in telecommunications and radio engineering, which are characterized by complexity and incomplete certainty of conditions
PLO04: Explain the results obtained from measurements in terms of their significance and relate them to the relevant theory
PLO06: Adapt to changes in information and communication network technologies, telecommunications and radio engineering systems
PLO14: Apply an understanding of the basic properties of the component base to ensure the quality and reliability of telecommunications and radio engineering systems and devices PRN15: Apply an understanding of the means of automation of design and technical operation of telecommunications and radio engineering systems in professional activities.
PLO16: Apply understanding of the basics of metrology and standardization in the field of telecommunications and radio engineering in professional activities.
PLO17: Understanding and compliance with domestic and international regulatory documents on the development, implementation, and technical operation of information and telecommunications networks, telecommunications and radio engineering systems.
PLO18: Find, evaluate, and use information from various sources necessary for solving professional tasks, including reproducing information through electronic search
PLO23: Select and apply technical solutions and perform the necessary calculations for the implementation of digital and analog signal processing methods
PLO24: Implement digital signal processing methods at the software and hardware levels
PLO25: Select and implement means and methods of information transmission in communication networks and apply network technologies
PLO26: Design and implement elements of intelligent technologies using software-configurable equipment
PLO29: Select the configuration, structure, main components, nodes, and elements of radio-electronic equipment depending on its purpose
PLO30: Apply a comprehensive approach to the design of telecommunications and radio-electronic equipment
PLO31: Apply the basics of designing radio-electronic equipment for intelligent systems and the latest component base and materials in the design of radio-electronic equipment for intelligent systems

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

Prerequisites for the educational program:

Schematic engineering

Post-requisites for the educational program:

Printed circuit board design

Communication methods in intelligent radio-electronic systems

3. *Course content*

Topic 1: Circuitry of operational amplifiers. Parameters of real OAs, their classification. Topic 2:

Linear circuitry on OAs.

Topic #3: Noise characteristics of operational amplifiers. Design of low-

noise circuits. Topic #4: Filters based on operational amplifiers.

Topic 5: Nonlinear devices based on OAs.

Topic 6: Features of circuit design based on real OAs. Topic 7:

Linear reference voltage power supplies.

Topic 8: Pulse voltage and current stabilizers.

Topic 9: Low-power network pulse voltage converters. Topic 10: Basic

principles of digital system design.

Topic 11: Analog-to-digital and digital-to-analog converters. Topic 12:

Data processing processors.

Topic #13: Data transmission in digital systems Topic #14:

Other peripheral devices

4. *Learning materials and resources*

1. U. Tietze, Ch. Schenk The semiconductor circuit design (set of 2 books). Volume 1., Book on Demand Ltd., 2018. – 830 p.
2. B. Carter, R. Mancini Op Amps for Everyone 5th Edition., Newnes; 5th edition, 2017. – 484 p.
3. P. Horowitz, W. Hill The Art of Electronics 3rd Edition., Cambridge University Press; 3rd edition, 2015. – 1020 p.
4. Sedov S.O. Analog Signal Processing. Circuitry. Calculations: Textbook – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, Polytechnika Publishing House, 2018. – 298 p.
5. Sedov S.O. Signal Processing Based on Operational Amplifiers. Circuitry. Calculations: textbook. – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2017. – 132 p.
6. Circuitry: Digital Electronics Devices [Electronic resource]: in 2 volumes: textbook for students majoring in Electronics / V. M. Ryabenky, V. Ya. Zhuykov, Yu. S. Yamnenko, A. V. Zagranichny; NTUU "KPI". – Electronic text data (2 files: 5.06 MB, 5.46 MB). – Kyiv, 2016. – 757 p. – Title from the screen.
7. Bondarenko, I. M. Modern Component Base of Electronic Systems: Textbook for Students of Higher Education Institutions / I. M. Bondarenko, O. V. Borodin, V. P. Karnauchenko; Ministry of Education and Science of Ukraine, Kharkiv National University of Radio Electronics. – Kharkiv: KNURE, 2020. – 268 p. – http://openarchive.nure.ua/handle/document/14062
8. Fundamentals of Circuit Theory. Calculation of Long Lines. Practical Guide: Textbook for Students Majoring in 172 Electronic Communications and Radio Engineering / A. V.

Bulashenko – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute. Igor Sikorsky, 2023. – 45 p.

Educational content

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

Lectures

Lecture No. 1: Internal circuitry of OPs

Lecture No. 2: Classification of OPs. Parameters of real OPs

Lecture No. 3: Using operational amplifiers to perform mathematical operations

Lecture No. 4: Using OPs to perform mathematical operations. Part 1

Lecture 5: Using OPs to perform mathematical operations. Part 2

Lecture 6: Types of regulators, their characteristics

Lecture 7: Regulators of automatic systems based on OP

Lecture 8: The concept of CAP stability, stability criteria

Lecture 9: Designing low-pass filters

Lecture 10: Development of high-pass filters

Lecture 11: Using operational amplifiers to perform nonlinear mathematical operations

Lecture 12: OP generators

Lecture 13: OP-based comparators

Lecture 14: Features of circuit design using real operational amplifiers. Dynamic range. Signal-to- noise ratio.

Lecture 15: Designing parametric and compensation stabilizers on operational

amplifiers Lecture 16: Integrated circuit technology of voltage and current stabilizers

Lecture 17: Pulse voltage and current stabilizers

Lecture 18: Low-power network pulse voltage converters

Lecture 19: Basic principles of electronic circuit design. Digital and analog circuits

Lecture 20: Data processing controllers. Microcontrollers, microprocessors, PLDs, DSPs

Lecture 21: Analog-to-digital converters.

Lecture 22: Digital-to-analog converters

Lecture 23: Data transmission in digital circuits. Basic concepts and definitions. SPI,

I2C protocols

Lecture 24: Data transmission in digital circuits. UART, RS232/RS485 protocols

Lecture 25: Data transmission in digital circuits. CAN, USB protocols

Lecture 26: Other peripheral devices

Lecture #27: Test

Practical classes

Practical class No. 1: Ideal operational amplifier

Practical class No. 2: Differential amplifier

Practical class No. 3: OP-based devices for performing mathematical operations

Practical class No. 4: HPF and bandpass active filters

Practical class No. 5: Designing high-pass filters. Circuitry of operational amplifiers

Practical lesson No. 6: Circuit design methods for reducing the impact of operational amplifier imperfections

Practical lesson No. 7: Inverting and non-inverting amplifiers with external offset voltage compensation circuits

Practical lesson No. 8: Automatic system controllers based on operational amplifiers

Computer workshops

Computer workshop No. 1: Investigation of the main methods of modeling in the LTspice

environment

Computer workshop No. 2: Investigation of the operation of a parallel ADC in the LTspice

environment

Computer workshop No. 3: Modeling of a DAC on capacitors in the LTspice environment

Computer workshop No. 4: Investigation of the effect of transmission line parameters on the signal

Computer workshop No. 5: Developing circuits using SLG46855 programmable

microcircuits

Computer workshop No. 6: Synthesis of a digital circuit using SLG46855 chip macroelements

Computer workshop No. 7: Synthesis of a digital-to-analog circuit using SLG46855 microchip macroelements

Computer workshop No. 8: Circuit synthesis based on description

Laboratory work

Laboratory session No. 1: Investigation of amplifier devices based on operational amplifiers. Part 1.

Laboratory session No. 2: Investigation of amplifier circuits based on operational amplifiers. Part 2.

Laboratory session No. 3: Investigation of OP-based amplifier circuits. Part 3.

Laboratory session No. 4: Investigation of devices for performing linear mathematical operations based on OP.

Laboratory session No. 5: Investigation of active filters based on OP.

Laboratory session No. 6: Investigation of generators based on OP.

Laboratory session No. 7: Investigation of generators based on operational amplifiers.

Laboratory session No. 8: Investigation of power amplifiers with operational amplifiers.

6. *Independent work*

Students must prepare in advance for lectures, practical classes, and laboratory classes.

Before lectures, it is necessary to review the theoretical material provided in previous

lectures. Before practical classes, it is necessary to review the relevant theoretical material.

It is mandatory to complete homework assignments, which must be done before the next practical class.

Theoretical preparation based on the material provided is mandatory for laboratory work.

Policy and control

7. *Academic discipline (educational component) policy*

To successfully complete the course, students must:

- Adhere to academic integrity: complete assignments and tests independently (especially during distance learning);
- Complete practical assignments on time or make up missed classes (in face-to-face learning) within the established deadlines;
- The defense of laboratory reports in face-to-face learning takes place immediately after their completion (or within the deadlines set by the teacher) in the form of an oral interview.

Class attendance:

- Lectures are not compulsory to attend. The minimum information required to master the course is provided in the form of presentations and lectures on the distance learning platform. However, attending lectures allows you to gain more in-depth knowledge and simplifies the completion of laboratory work and writing a modular test;
- Attendance at practical classes and laboratory work is mandatory during face-to-face teaching.

8. *Types of assessment and the learning outcomes assessment rating*

system (LOAS) The rating system provides for the following distribution

of current assessment points:

Completion and defense of laboratory work — maximum 5 points for each, 5 x 8 = 40;
Homework assignments — maximum 3 points for each, 5 x 3 = 15;
Defense of computer workshops 1-8 — 1 point for each 8 x 1 = 8
Modular test — 10 points for each, 2 x 10 = 20 points.
Completion of practical tasks 1–8 — 1 point for each 8x1=8 points
Completion of RGR — 9 points.

Table of correspondence between rating points and university scale grades

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

9. *Additional information on the discipline (educational component)*

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

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Working program of the academic discipline (syllabus):
Compiled by Adamenko V. O.; Kirpatenko I. M.;
Approved by the PRE Department (Minutes No. 06/2025 dated 25.06.2025)
Approved by the methodological commission of the faculty/research institute (protocol No. 06/2025 dated 26.06.2025)