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

Department of Applied Radio Electronics

[RE-21] RADIO TECHNICAL SYSTEMS

Curriculum of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	G - Engineering, manufacturing, and construction
Specialty	G5 - Electronics, electronic communications, instrument engineering, and radio 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 4th year, spring semester
Scope of the discipline	4 credits (Lectures: 16 hours, Practical classes: 30 hours, Laboratory work: 30 hours, Independent work: 74 hours)
Semester control/control measures	Credit
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian
Information about the course coordinator/teacher s	Lectures: O. Titenko, Labs: O. Titenko
Course location	

Course program

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

The program of the academic discipline "Radio Engineering Systems" (RES) has been developed in accordance with the educational and professional program of the first (bachelor's) level of higher education in the specialty 172 Electronic Communications and Radio Engineering.

The course is elective. Subject of the course:

Study of the basics of the construction of radio engineering systems for information transmission.

The goal of the credit module is to develop students' ability to solve basic problems in the construction of radio engineering communication systems.

As a result of studying the discipline, students should **know**:

the basics of radio engineering systems design, signal processing methods in radio engineering systems, multi-channel systems organization, and radio engineering systems structures.

As a result of studying the discipline, students should be able to:

analyze and create structures of the main elements of radio engineering systems; design (develop) analog-

digital equipment nodes.

General competencies

GC 01 Ability to think abstractly, analyze, and synthesize
GC 04 Knowledge and understanding of the subject area and understanding of professional activity.
GC 07 Ability to learn and master modern knowledge.

Professional competencies

PC 01 Ability to understand the essence and significance of information in the development of a modern information society
PC 03 Ability to use basic methods, means, and tools for obtaining, transmitting, processing, and storing information.
PC 04 Ability to perform computer modeling of devices, systems, and processes using universal application software packages
PC 12 Ability to perform work related to managing traffic flows in information and telecommunications networks
PC 14 Readiness to study scientific and technical information, domestic and foreign experience on the subject of investment (or other) projects in the field of telecommunications and radio engineering
PC 15 Ability to perform calculations in the process of designing structures and means of information and telecommunications networks, telecommunications and radio engineering systems, in accordance to technical specifications using both standard and independently developed methods, techniques, and software tools for design automation
PC 16 Ability to apply standard calculation methods in the design of telecommunications and radio engineering devices and systems
PC 20 Ability to select methods and means of information processing using intelligent technologies
PC 21 Ability to take a comprehensive approach to the development of radio-electronic equipment

Program learning outcomes

PLO 01 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

PLO 02 Apply the results of personal search and analysis of information to solve qualitative and quantitative problems of a similar nature in information and communication networks, telecommunications and radio engineering systems

PLO 13 Apply fundamental and applied sciences to analyze and develop processes occurring in telecommunications and radio engineering systems

PLO 14 Apply understanding of the basic properties of the component base to ensure the quality and reliability of telecommunications and radio engineering systems and devices.

PLO 20 Explain the principles of construction and operation of hardware and software complexes of control and maintenance systems for the development, analysis, and operation of information and telecommunications networks, telecommunications and radio engineering systems.

PLO 23 Explain the principles of construction and operation of hardware and software complexes of control and maintenance systems for the development, analysis, and operation of information and

telecommunications networks, telecommunications, and radio engineering systems.

PLO 24 Implement methods of digital signal processing at the software and hardware levels

PLO 25 Select and implement means and methods of information transmission in communication networks and apply network technologies

PLO 26 Design and implement elements of intelligent technologies using software-configurable hardware

PLO 27 Apply basic methods and techniques for obtaining information

PLO 29 Select the configuration, structure, main components, and elements of radio- electronic equipment depending on its purpose

PLO 30 Apply a comprehensive approach to the design of telecommunications and radio-electronic equipment

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

Before starting the course, it is desirable to complete the disciplines "Radio Transmission Devices" and "Radio Receiving Devices."

3. Contents of the discipline

Topic 1. *Basic concepts and provisions of systems theory*

Basic concepts of systems theory. System properties. Classification of systems. Technical systems, basic concepts

Topic 2. *The concept of radio engineering systems*

Classification of radio engineering systems. Structural diagram of an information transmission system. Ensuring the efficiency of radio engineering systems. Problems of signal detection and optimal processing. The problem of electronic warfare. Electromagnetic compatibility of radio engineering systems. Optimization and adaptation of radio engineering systems

Topic 3. *Key RTS indicators*

Terms and definitions. Key technical characteristics of RTS stations

Topic 4. *Radio lines*

International radio frequency allocation. Frequency allocation table. "Radio communication regulations."

Topic 5. *Multichannel communication systems.*

General provisions. Fundamentals of multi-channel message transmission theory. Frequency division of channels. Time division of channels. Division of signals by shape

Topic 6. *Radio relay systems.*

Principles of radio relay equipment design. Repeaters. Radio relay configurations and redundancy methods. Radio relay energy and quality indicators. Prospects for radio relay development. Tropospheric radio relay systems. Station design features. Features of radio signal reception in tropospheric radio relay systems.

Topic 7. *Satellite communication systems.*

Satellite orbits. Geostationary satellites. Low Earth orbit satellites (LEOS) and medium Earth orbit satellites (MEOS). Frequency bands. Quality of service indicators. Satellite system configurations. Bandwidth allocation. Satellite repeaters. Modulation and noise-resistant coding. Disadvantages of satellite communications.

Topic 8. *Radio engineering systems for mobile communications.*

General provisions. Professional mobile radio communication systems. Cellular communication. General provisions. 2G, 3G, 4G, 5G, 6G systems. Personal radio paging systems. Cordless telephone systems.

RECOMMENDED LIST OF LABORATORY WORKS

The purpose of laboratory classes is to experimentally verify theoretical knowledge, acquire skills in calculation, research, measurement, and evaluation of specific RTS parameters.

Laboratory classes are conducted in the form of a computer workshop. Each student has their own workstation (personal computer). Students receive laboratory work assignments in advance. Before the start of the class, a survey is conducted to assess the student's readiness to perform the work. After completing the work, the results are defended and discussed. A report on the laboratory work is prepared.

Approximate topics of classes:

1. Introduction to the Radio Mobile program.
2. Calculation of radio routes in the administrative area.
3. Introduction to mobile communication system monitoring programs.

RECOMMENDED INDIVIDUAL ASSIGNMENTS

The main objectives of tests are to encourage students to work consistently throughout the semester and to check their acquired knowledge. One test is planned. Individual test assignments are formed according to the relevant sections of the discipline and are assessed in points, which constitute one of the components of the starting rating.

4. Teaching materials and resources

Recommended reading

1). O. O. Semenova. Mobile communication systems. Textbook – Vinnytsia: VNTU, 2017. – 185 p.

2). Narytnik T. M., Pochernyayev V. M., Povkhlib V. S. Digital radio relay and tropospheric communication lines (basics of calculation): textbook. – Odessa: O. S. Popov ONAT, 2019. – 164 p.

3). Brailovsky V. V., Rozhdestvenskaya M. G. Multichannel information transmission systems. – Textbook – Chernivtsi: Chernivtsi National University, 2017. – 140 p.

4). Gol V.D., Irkha M.S. Telecommunications and Information Networks: Textbook. Kyiv: ISZSI Igor Sikorsky KPI, 2021. 250 p.

5). Alyoshin G. V., Panchenko S. V., Prikhodko S. I. Optimization of Digital Transmission Systems: Textbook. – Kharkiv: UkrDUTZ, 2019. – 142 p.

6). Brian J. Henderson, P. Eng. Radio Mobile. Program Operating Guide. VE6ZS, Calgary, Alberta, Canada. December 30, 2011

Educational content

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

Lectures

No	Lecture topic and list of main questions (list of teaching aids, references to literature and assignments for independent study)
1	**Topic 1. Basic concepts and provisions of systems theory** Basic concepts of systems theory. System properties

2	**Topic 1. Basic concepts and provisions of systems theory (continued)** Classification of systems. Technical systems.
3	**Topic 2. The concept of radio engineering systems** Classification of radio engineering systems.
4	**Topic 3. Main characteristics of radio engineering systems** Terms and definitions. Main technical characteristics of RTS stations. **Topic 4.** Radio lines International distribution of radio frequencies. Frequency distribution table. "Regulations radio communication".
5	**Topic 5. Multichannel communication systems.** Fundamentals of multi-channel message transmission theory. Frequency division of channels.
6	**Topic 5. Multichannel communication systems (continued).** Time division multiplexing. Cyclic synchronization systems. Practical group signals TimePC.
7	**Topic 5. Multichannel communication systems (continued).** Signal classification by shape**.** Methods for obtaining complex signals.
8	**Topic 5. Multichannel communication systems (continued).** Obtaining complex signals using frequency-time coding. Practical signals with code division.
9	**Topic 6. Radio relay systems.** Principles of radio relay equipment design. Repeaters. Configurations and methods for radio relay system redundancy. Prospects for the development of radio relay systems. Tropospheric radio relay systems.
10	**Topic 7. Satellite communication systems.** Satellite orbits. Geostationary satellites. Low Earth orbit satellites (LEOS) and medium Earth orbit satellites (MEOS). Frequency bands. Communication quality indicators. Satellite system configurations. Bandwidth distribution capacity.
11	**Topic 7. Satellite communication systems (continued).** Satellite repeaters. Modulation and noise-resistant coding. Disadvantages of satellite communications
12	**Topic 8. Radio engineering systems for mobile communications.** General provisions. Professional mobile radio communication systems.
13	**Topic 8. Radio engineering systems for mobile communications (continued).** Cellular communications. General provisions. 2G and 3G systems.
14	**Topic 8. Radio engineering systems for mobile communications (continued).** Cellular communications. 4G, 5G, 6G systems.
15	**Topic 8. Radio engineering systems for mobile communications (continued).** Personal radio paging systems. Cordless telephone systems.

5 Laboratory classes

The main objectives of the laboratory class cycle are to develop the relevant skills and experience in students.

No.	Name of the class topic and list of main questions
1	Introduction to the Radio Mobile program.
2	Calculation of radio routes in the administrative district.
3	Introduction to mobile communication system monitoring programs.

6. Independent work by students

No	Title of the topic for independent study	Number of hours of independent work
1	**Topic 1. Basic concepts and provisions of systems theory** ***Independent study assignment:*** Technical systems, classification. [1, p. 11]	4
2	**Topic 2. Radio lines** ***Assignment for independent study:*** International distribution of radio frequencies. Frequency distribution table. "Regulations Radio Communications Regulations." [1, p. 51]	4
3	**Topic 3. Main indicators of RTS** ***Assignment for independent study:*** Terms and definitions. Main technical characteristics of RTS stations. **[1, p. 51]**	4
4	**Topic 4. The concept of radio engineering systems** ***Assignment for independent study:*** Classification of radio engineering systems. [1, p. 69]	4

5	**Topic 5. Multichannel RTS** ***Independent study assignment:*** Classification of signals by form**.** [1, p. 80]	12
6	**Topic 6. Radio relay systems.** ***Assignment for independent study:*** Configurations and methods of radio relay line (RRL) redundancy. Energy and quality indicators of RRL. Prospects for radio relay line development. [1, p. 148]	8
7	**Topic 7.** Tropospheric radio relay systems ***Assignment for independent study:*** Modem construction [9, p. 156]	4
8	**Topic 8. Satellite RTS** ***Independent study assignment:*** Modulation and noise-resistant coding. [9, p. 156]	10
9	**Topic 10. Mobile communication RTS** ***Ass***ignment ***for independent study:*** Promising mobile communication systems. Personal radio paging systems. wireless telephone systems. [9, p. 191]	16

Individual assignments

The program includes a calculation assignment as an individual task. Students are asked to calculate the route of a radio relay system. The results obtained are input data for laboratory work.

Control works

For the RTS credit module, the curriculum provides for modular control, which is carried out by means of tests. Their purpose is to check the quality of the knowledge acquired and the quality of independent work. Tests are carried out as independent work by students.

Policy and control

7. Policy of the academic discipline (educational component)

Rules for attending classes (both lectures and practical/laboratory classes)

Laboratory work is compulsory and must be completed. If these classes are missed, they should be made up during consultations or with other groups. If lectures are missed, tests on the material covered in the missed class must be taken and passed. Lecture materials and videos are posted on the LMS.

Defense of laboratory work

Laboratory work is defended on the day the laboratory work is completed. The student receives two grades. The first is for activity and initiative during the laboratory work and individual classes. The second is for the defense and answers to control questions.

Defense of individual assignments

As part of their independent work, students complete assignments based on lecture materials. Based on the results of the assessment, course participants receive feedback from the instructor and a grade. Individual assignments cannot be retaken.

Incentive and penalty points and academic integrity policy

The most active students and students who complete individual assignments in an exemplary manner can receive up to 10 points towards their semester grade.

Penalty points are applied in cases of passing off someone else's work as one's own, with mandatory reworking of the work.

Deadline and retake policy

If the deadlines for submitting assignments are missed, the maximum score for the assignments is reduced by 10%.

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

A student's grade for a course consists of points awarded for:

1. Attending lectures and taking notes.
2. Completing and defending laboratory work.
3. Completing the module test.
4. Performing calculation work
5. Taking the exam.

Grading system and assessment criteria:

1. Attending lectures and taking notes.

Attending lectures and taking notes: Completing

calculation work.

Maximum number of points for completing the calculation work: 15 points.

1. Laboratory work.

Work completed in full, defended: maximum 25 points.
Work not completed during class or not defended on time: minus 5 points.

Maximum number of points for all laboratory work: 20 points.

Students who have not completed the RR are not allowed to perform laboratory work (the work is considered not completed and not defended on time).

1. Modular control work.

Weighting of the modular control work: 10 points.

Bonus points

Creative approach and high level of knowledge: additional +10 points.

Calculation of the rating scale

Total weighted points for control measures during the semester:

= 5 + 15 + 20 + 10 + 10 = 60 points.

Exam: (two theoretical questions: 10+10=20 points, task: 20 points). The rating

scale for the discipline is:

The rating scale for the RTS discipline is 100 points.

- A prerequisite for admission to the exam is the absence of debts on the course, as well as a starting rating of at least 30 points.
- A student who receives less than 10 points on the exam (or 0 points on one of the 3 questions) is considered to have received a final grade of "unsatisfactory" regardless of their semester rating.
- The student's calendar assessment is based on their current rating at the time of assessment. If this rating is at least 50% of the maximum possible at the time of assessment, the student is considered to have passed.

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

Number of points	**Rating**
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)

List of exam *questions*

1. Standardization organizations in the field of telecommunications
2. Basic concepts of systems theory
3. System properties. Classification of systems
4. Technical systems, basic concepts
5. International radio frequency allocation
6. Frequency allocation table. "Radio Communication Regulations"
7. Basic terms and definitions of RTS
8. Basic technical characteristics of RTS stations
9. Classification of radio technical systems
10. Structural diagram of the information transmission system
11. Ensuring the effectiveness of radio engineering systems
12. Problems of signal detection and optimal processing
13. The problem of electronic warfare
14. Electromagnetic compatibility of RTS
15. Optimization and adaptation of RTS
16. General provisions for multichannel RTS
17. Fundamentals of the theory of multichannel message transmission
18. Frequency division of channels in multichannel RTS
19. Time division of channels in multichannel RTS
20. Signal division by shape in multichannel RTS
21. Principles of radio relay equipment design
22. RRL repeaters
23. Configurations and methods of radio relay system redundancy
24. Energy and quality indicators of radio relay lines
25. Prospects for the development of radio relay systems
26. Tropospheric radio relay systems. Features of station construction.
27. Features of radio signal reception in tropospheric radio relay systems
28. RTS satellite orbits
29. Geostationary satellites
30. Low Earth Orbit Satellites (LEOS) and Medium Earth Orbit Satellites (MEOS)
31. Frequency bands of satellite RTs
32. Satellite RTS communication quality indicators
33. Satellite **system** configurations*
34. Satellite RTS bandwidth distribution
35. Satellite repeaters
36. Modulation and noise-resistant coding of satellite RTS
37. Disadvantages of satellite radio communication
38. Radio systems that use ionospheric scattering of radio waves and reflection from meteor trails
39. Professional mobile radio communication systems. Main **characteristics***
40. TETRA system
41. Organization of a cellular network
42. Multiple use of frequencies in a cellular network
43. Increased bandwidth in a cellular network
44. How cellular systems work
45. Effects of radio wave propagation in mobile communications
46. Handover in mobile communications
47. Power control in a cellular network
48. Traffic control in a cellular network
49. GSM standard – 2G. Main characteristics
50. CDMA standard – 3G. Main characteristics
51. LTE standard – 4G. Main characteristics
52. LTE standard – 5G, 6G. Main characteristics
53. Personal radio paging systems
54. Wireless telephone systems

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

Laboratory 508-17

Work program for the academic discipline (syllabus):
Compiled by O. Titenko;
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)