



**СПбГЭТУ «ЛЭТИ»**  
ПЕРВЫЙ ЭЛЕКТРОТЕХНИЧЕСКИЙ

MINISTRY OF EDUCATION AND SCIENCE OF RUSSIA  
federal state autonomous educational institution of higher education

**"St. Petersburg State Electrotechnical University" LETI "named after. IN AND. Ulyanov (Lenin)" (St. Petersburg Electrotechnical University "LETI")**

---

I approve:

Vice-Rector for Research

\_\_\_\_\_ Tupik V.A.

" \_\_\_\_ " \_\_\_\_\_ 2022

## **WORKING PROGRAMM**

disciplines

"Radio engineering, including television systems and devices»

for the preparation of graduate students in a scientific specialty

2.2.13. -Radio engineering, including television systems and devices

Saint Petersburg

2022

## **DISCIPLINE STRUCTURE**

Supporting Faculty: FRT

Supporting department: TOR

Well 4

Semester 8

### **Types of occupations**

Lectures

Independent work

### **Type of intermediate certification**

Exam (semester) 8

Developer Sergienko A. B.

Head of dep. of TOR Ushakov V. N.

Head of DDPS Tumarkin A.V.

## **DISCIPLINE ABSTRACT**

### **"RADIO ENGINEERING, INCLUDING TELEVISION SYSTEMS AND DEVICES»**

The discipline includes the following areas of knowledge: radio circuits and signals; electrodynamics and propagation of radio waves; circuitry of analog electronic devices; digital devices and microprocessors; microwave devices and antennas; electronics; devices for generating and forming signals; devices for receiving and converting signals; computing devices and systems; radio engineering systems; statistical theory of radio engineering systems.

## **SUBJECT SUMMARY**

### **"RADIOTECHNICS, INCLUDING SYSTEMS AND DEVICES OF TELEVISION"**

The discipline considers the following subjects: radiotechnics circuits and signals; electrodynamics and radiowave propagation; analog electronic devices design; digital devices and microprocessors; SHF devices and antennas; electronics; signal generators and formers; receivers and signal converters; computing devices and systems; radiotechnics systems; statistical theory of radiotechnics systems.

## **GOALS AND OBJECTIVES OF THE DISCIPLINE**

1. The study of methods for transmitting information over a radio channel. Systematization of knowledge in the field of wireless communication.
2. Formation of skills in the development of nodes of the system for transmitting and receiving information over a radio channel based on a modern element base.
3. Mastering the principles of building radio engineering systems. Formation of the ability to evaluate the parameters of radio engineering systems at the design stage.

## **THE CONTENT OF THE DISCIPLINE**

### **Introduction**

The discipline covers areas of knowledge that are specialized in the preparation for the direction "Radio engineering, including television systems and devices" (2.2.13), allows you to independently master or repeat the material necessary for the successful passing of the candidate exam.

### **Topic 1. Statistical radio engineering**

Mathematical description and methods of signal and interference analysis are studied: discrete representations of signals, integral representations of signals; Fourier transform, Hilbert and other integral transformations, basic parameters of radio signals, modulation; noise and interference as random processes, their characteristics, parameters and properties.

Models of radio circuits and devices: linear circuits, circuit characteristics and circuit analysis methods; active circuits; the passage of signals and interference through linear circuits with constant parameters; nonlinear circuits, their characteristics and methods of analysis, devices based on nonlinear circuits; discrete linear systems, their characteristics, methods of analysis and synthesis.

Digital signal processing methods: signal sampling by time and quantization by level, methods of analog-to-digital conversion; digital signal processing algorithms and methods for their synthesis; digital filtering and digital spectral analysis.

### **Topic 2. Radio communication and television systems**

Radio systems and information transmission devices are studied: problems of information transmission, a measure of the amount of information, the bandwidth of a communication channel, coding, coherent and incoherent reception of signals, theories of potential noise immunity, signal separation methods and multichannel systems, information protection, synchronization.

Radio-television systems: formation, transmission, reception and conservation of images; methods for decomposing images into elements; frame change synchronization, TV signal format; television signal standards; transmission of sound

accompaniment; transmitting television camera and converting the optical image into an electrical signal; methods of storing, compressing and storing images; digital television, satellite television systems, television surveillance and surveillance systems, security television systems.

Radio control systems and devices: tasks of object control; theory of automatic control; spacecraft control; features of radio links for object control; synthesis and analysis of radio control systems.

Electronic warfare systems: tasks of electronic warfare; electronic intelligence, determination of the parameters of radio signals; methods for determining the location of radio communication systems; types of active interference and active interference generators.

Radio engineering systems and devices in biology, medicine, metrology and other branches: tasks of radio systems in biology, medicine and metrology; use of ultrasonic signals; medical devices for microwave, radiometry, introscopy, tomography, cardiography. The use of television systems in industry, biology and medicine.

Methods for designing and constructing radio-electronic means: methods of standardization in design; integrated microcircuit engineering; printed circuit; ways to protect radio-electronic equipment from environmental influences, dynamic loads and electromagnetic radiation.

### **Topic 3. Radio engineering devices**

The basics of radiation and reception of radio waves, the propagation of electromagnetic waves are studied: Maxwell's equations, boundary conditions; solution of homogeneous equations of electrodynamics; diffraction and interference; sewerage of radio waves; electromagnetic resonators. Elements of antenna theory: elementary emitters; near and far zones; receiving and transmitting antennas; technical implementation of antennas of various radio wave bands.

Devices for generating and forming signals: generators and self-oscillators; frequency stability; quantum frequency standards; frequency multipliers; frequency synthesizers; generation and amplification of microwave oscillations.

Devices for receiving and converting signals: types of radio receivers; radio receiver units, mixers, local oscillators, detectors, amplifiers of various ranges; automatic adjustments in radio receivers; element base of radio receivers; modeling of radio receivers and their elements; secondary power supplies.

### **Conclusion**

Development prospects radio engineering, including television systems and devices.

If the discipline is implemented in groups with a small number, classes in individual sections can take the form of an orientation lecture, issuing and explaining a task on a topic, and current control can take place in the form of a presentation and defense of the completed task by a graduate student.

General recommendations for the completion of individual tasks are available to the graduate student in printed or electronic form (on the University website), or the graduate student can receive recommendations from the teacher responsible for the discipline during consultation hours. The task is formulated taking into account the topics of the PhD student's dissertation research within the framework of the discipline under study.

## **EDUCATIONAL AND METHODOLOGICAL SUPPORT OF DISCIPLINE**

### **Methodological recommendations for the implementation of the discipline**

#### **Methodological recommendations for teachers:**

Before starting to teach the discipline, the teacher must:

- know the goals and objectives of teaching the discipline;
- imagine what knowledge, skills and abilities a graduate student should acquire in the process of studying this discipline;
- to clearly understand in the formation of what results of mastering the postgraduate program the discipline is involved.

If the curriculum for the discipline provides for an exam, it is recommended to conduct it in the form of an individual conversation with a graduate student on the questions formulated in the funds of the discipline's assessment tools, using questions from various sections of the discipline, thereby ensuring a more complete test of the graduate student's knowledge.

In his activities, the teacher must be guided by local regulations governing educational activities in educational programs for the training of highly qualified personnel at the university.

#### **Methodological recommendations for independent work of graduate students:**

The study of each discipline should be accompanied by independent work of a graduate student with literature sources and Internet information resources recommended by teachers in all sections of the discipline.

A number of issues to be studied as part of the discipline are quite well developed in the educational literature, presented in scientific papers, collections of papers, articles, and on the Internet. These questions can be transferred to graduate students for independent study. Such work is built on the basis of tasks prepared by the teacher with a list of questions to which the student must find answers in the process of self-study. Both whole topics and individual questions can be studied independently as part of the topics indicated by the teacher, but not fully disclosed by him. To consolidate the material, notes are taken, abstracts, essays are prepared or reports are made. The degree

of mastering independently studied materials is necessarily checked by control measures using the fund of evaluation tools for the discipline.

A special place should be given to counseling as one of the forms of training and control of independent work. Counseling involves a specially organized interaction between the teacher and graduate students, it is assumed that the consultant either knows a ready-made solution that he can prescribe to the consulted person, or he owns methods of activity that indicate the way to solve the problem.

**List of basic and additional educational literature,  
necessary for mastering the discipline**

No.	Title, bibliographic description	Number of copies in the Bible (at the cafe)
Main literature		
1	Radio engineering systems: textbook for students. higher textbook establishments. Ed. Yu. M. Kazarinova. - Ed. center "Academy", 2008. - 592 p.	67
2	Konovalov G.F. Radioautomatics: Textbook for universities. - M: "IPRZHR", 2003.	95
3	M. T. Ivanov, A. B. Sergienko, V. N. Ushakov. Radio engineering circuits and signals: Textbook for universities. Third generation standard / Ed. V. N. Ushakov. - St. Petersburg: Peter, 2014.	75
4	A. B. Sergienko. Digital signal processing: Proc. allowance. 2nd ed. - St. Petersburg: Peter, 2006. - 751 p.	68
additional literature		
1	Baskakov S. I. Radio engineering circuits and signals. Guide to problem solving. - M.: Higher. school, 2002.	92
2	Maksimov V.M. Microwave devices: fundamentals of theory and elements of the path. — M.: Science Press, 2002.	145

**The list of resources of the information and telecommunication network "Internet" used in the development of the discipline**

No.	Email address
1	<a href="http://www.radiotec.ru/">http://www.radiotec.ru/</a>
2	<a href="https://re.eltech.ru/">https://re.eltech.ru/</a>



Information technologies (operating systems, software for general and specialized purposes, as well as information reference systems) and the material and technical base used in the implementation of the educational process in the discipline comply with federal state requirements.

Specific forms and procedures for current knowledge control and intermediate certification, including a list of examination questions (Appendix 1), as well as guidelines for students on independent work when mastering disciplines, are brought to the attention of students in the first lesson.

## List of exam questions by discipline

**"RADIO ENGINEERING, INCLUDING TELEVISION SYSTEMS AND  
DEVICES»**

1. Discrete representations of signals. Complete orthonormal systems.
2. Integral representations of signals. Fourier, Hilbert transformations.
3. Decomposition of a signal according to a given system of functions. Harmonic signal analysis.
4. Spectra of periodic and non-periodic signals.
5. Discrete signals and their analysis. Discrete Fourier and Hilbert transforms and their properties.
6. Radio signals with amplitude and angular (frequency and phase) modulation and their spectra. Radio signals with complex (mixed) modulation and their spectra.
7. Probability distribution densities, characteristic functions and distribution functions of random processes. Energy characteristics of random processes.
8. Spectral density. Properties of correlation functions. Wiener-Khinchin theorem.
9. Stationarity and ergodicity of random processes.
10. Gaussian random process and its characteristics. Processes close to Gaussian.
11. The passage of signals and interference (deterministic and random oscillations) through linear circuits with constant parameters.
12. Nonlinear circuits and devices. Methods for the analysis of nonlinear circuits.
13. Methods of analysis and synthesis of discrete radio engineering devices. digital filters. Recursive and non-recursive digital filters.
14. Impulse characteristics of digital filters. Spectral analysis using discrete and fast Fourier transforms.
15. Digital filtering and digital filters. Quantization and rounding errors. Methods for calculating digital filters.
16. Digital filtering in the time and frequency domains. Digital spectral analysis. Fast Fourier Transform.

17. A measure of the amount of information (Hartley, K. Shannon). Entropy of the source of information and its properties. redundancy.
18. Throughput of the communication channel. Shannon formula. Basic coding theorem. The concept of encoding information: code, alphabet, base and value of the code.
19. Theories of potential noise immunity V.A. Kotelnikov. Noise immunity criterion for receiving continuous messages.
20. Fundamentals of the theory of signal separation and multichannel information transmission systems.
21. Methods for decomposing images into elements. The principle of sequential transmission of image elements.
22. Synchronization of the frame change and the beginning of the line sweep. TV signal format.
23. Converting an optical image into an electrical signal in a transmitting television camera.
24. Elements of the theory of automatic control. Control objects. The servo control loop and its main links.
25. Methods for determining the location of radio and television systems.
26. Active interference generators. Types of active interference.
27. Microwave medical devices, radiometry, introscopy, tomography, cardiography.
28. Radio engineering devices and devices in metrology.
29. The use of television systems in industry, biology and medicine.
30. Integrated microcircuitry, large (LSI) and extra-large (VLSI) integrated circuits.
31. Ways to protect electronic equipment from environmental influences, dynamic overloads and electromagnetic radiation.
32. Maxwell's equations. Border conditions. The energy of the electromagnetic field.
33. Propagation of radio waves in natural conditions. Phenomena of diffraction and interference.
34. Sewerage of radio waves. Waveguides and feeders.

- 35. Electromagnetic resonators.
- 36. Receiving and transmitting antennas, their parameters and characteristics.
- 37. Influence of the type of distribution of the electromagnetic field in the antenna opening on the main parameters of the antennas.
- 38. Signal frequency converters, mixers and local oscillators.
- 39. Signal detectors: amplitude, frequency and phase.
- 40. Amplifiers of various frequency ranges.
- 41. Automatic adjustments in radio receivers.