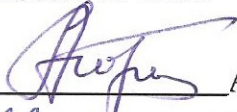


Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Educational Institution of Higher Education
"Peter the Great St. Petersburg Polytechnic University"

Institute of Electronics and Telecommunications

APPROVED

Director of IEaT


A.S. Korotkov
"23" October 2024

PROGRAM

**entrance test for applicants to the master's degree program in the direction of
training / educational program: 11.04.02 Infocommunication Technologies And
Communication Systems /
11.04.02_05 «Microelectronics of Telecommunication Systems» (international
educational program Microelectronics of Telecommunication Systems)"**

Saint Petersburg

2024

ANNOTATION

The program contains a list of topics (questions) on the disciplines of the professional curriculum for bachelor's training plan in the major 11.03.02 **Infocommunication technologies and communication systems**, included in the test assignments of entrance exams for the master's degree.

Entrance test is evaluated on a 100-point scale. The minimum number required for passing the interdisciplinary examination is 50 points (50%).

Entrance tests for English-language educational programs are conducted in English.

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The program was reviewed and recommended for publication by the educational and methodological council of the **Institute of Electronic and Telecommunication** (Protocol No. 2 dated “22” October 2024).

1. DISCIPLINES INCLUDED IN THE PROGRAM OF INTERDISCIPLINARY EXAM

- 1.1. Electronics
- 1.2. Theory of electrical networks
- 1.3. Analog circuit design
- 1.4. Digital circuit design

2. CONTENT OF EDUCATIONAL DISCIPLINES

2.1. " Electronics "

1. Semiconductor diodes

Features of operation of the device and semiconductor diodes: rectifier, universal, pulse, ultra-high-frequency, zener diodes, varicaps, tunnel and inverted diodes, Schottky diodes. Volt-ampere characteristics of diodes for permanent purposes. Basic parameters of semiconductor diodes. Classification and conventional designations of semiconductor diodes.

2. Bipolar transistors

The device, principles and modes of operation, connection diagrams. The main physical processes in a bipolar transistor. Active mode of operation of a bipolar transistor. Static characteristics of a bipolar transistor when connected according to circuits with a common base and with a common emitter. Bipolar transistor as a linear four-terminal device. The system of h-parameters. Amplifying properties of bipolar transistors in various connection diagrams. The influence of temperature, characteristics and amplifying properties of bipolar transistors. Operation of a bipolar transistor in the key mode, its frequency and pulse properties. Classification and symbols of bipolar transistors.

3. Field-effect transistors

Field-effect transistors, their types, device, connection diagrams. Field-effect transistors with a controlled electron-hole junction and a metal-semiconductor junction: physical principle of operation, characteristics and parameters. Field-effect transistors with an insulated gate: the mechanism of formation of an induced or built-in channel. Volt-ampere characteristics and parameters. Classification and conventional designations of field-effect transistors. Charge-coupled devices, their device, principle of operation and purpose.

Literature to prepare for exam:

1. Semiconductor appliances: textbook for universities on educational direction of training bachelors, masters and graduated specialists "Electronics and microelectronics" / V.V. Pasyukov, L.K. Chirkin . — 9th ed. — SPb., 2009 .—478, with ill.;23 cm .— Bibliography : p. 460.
2. Basics of microelectronics: [textbook for universities] / I.P. Stepanenko. —2nd ed. – Moscow: Laboratory Basic knowledge, 2004.—488 with ill.; 22 cm.

2.2. Theory of electrical networks

1. Basic concepts and laws of theory of electrical networks

Idealized elements of an electric circuit: passive resistance, inductance, capacitance; active – voltage and current sources. Methods for describing the properties of electric circuit elements: static characteristics, differential parameters, equivalent circuits of resistors, capacitors, inductors at different frequencies. Kirchhoff's laws. The number of independent equations according to the first and second Kirchhoff's laws

2. Linear electrical networks in mode of harmonic current

Periodic currents and voltages. Harmonic currents and voltages. Effective and average values of harmonic currents and voltages. Complex amplitude method. Representation of harmonic functions, their integrals and derivatives by complex quantities. Complex amplitude. Complex resistances and admittances; active and reactive resistances and admittances. Ohm's and Kirchhoff's laws in complex form. Vector diagram. Complex power, active and reactive power. Condition for maximum power transfer from the generator to the load

3. Transformation schemes for electrical chains

Series connection of two-terminal devices, parallel connection of two-terminal devices. Equivalent sections of a circuit with series and parallel connection. Equivalence of current and voltage sources. Transformation of a circuit with two nodes.

4. Methods for calculation of complex electrical networks

Application of Kirchhoff's laws to the calculation of complex electrical circuits. Loop current method. Nodal voltage method. Superposition method. Reciprocity theorem. Theorems on the equivalent generator of current and voltage. Calculation of circuits with mutual inductance. Leakage inductance. Coupling coefficient. Linear transformer. Ideal transformer. Autotransformer device. Equivalent circuit of a double-circuit circuit with a transformer.

5. Resonant phenomena in electrical networks

Forced oscillations in a series oscillatory circuit. Resonance phenomenon.

Voltage resonance. Resonance curve equation. Forced oscillations in a parallel oscillatory circuit. Current resonance. Input resistance of the circuit at resonance and in the region of small detunings. Effect of internal resistance of the source on the characteristics of the resonant system. Reduced quality factor. Complex circuits. Switching factor. Filtering properties of resonant circuits. Coupled circuits. Resonance curves of coupled circuits. Passband of coupled circuits. Connection of an aperiodic circuit with an oscillatory one.

Literature to prepare for exam:

1. Theoretical foundations of electrical engineering. 30 lectures on the theory of electrical networks: textbook for universities in the direction 550000 - "Technical Sciences", 650000 - "Engineering and Technology " and the discipline "Theoretical Foundations of Electrical Engineering" / A.B. Novgorodtsev – Piter, 2006.
2. Theoretical foundations of electrical engineering: textbook for universities in the areas of training bachelor 's and master's degrees in "Electrical Engineering, Electromechanics and Electrotechnology" and "Power Engineering" [in 3 volumes]. / K. S. Demirchyan [and others] — M. [and others] Piter, 2006.

2.3. Analog circuit design

1. *Analysis of characteristics of analog circuits*
Analysis of analog device characteristics for direct current. Analysis of analog device characteristics in small signal mode. Analysis of transient processes in analog devices. Machine analysis of analog device characteristics. Symbolic analysis of analog device characteristics.
2. *Configuration circuits of transistors and amplifier based on them*
Amplifying stage on a transistor with connection according to the common emitter (CE) circuit. Amplifying stage on a transistor with connection according to the common source (CS) circuit. Amplifying stage on a transistor with connection according to the common base (CB) circuit. Amplifying stage on a transistor with connection according to the common gate (CG) circuit. Amplifying stage on a transistor with connection according to the common collector (CC) circuit.
3. *Current mirrors*
Characteristics of current mirrors. Basic circuit of a current mirror.
4. *Operating principle and influence of feedback on the main indicators of*

amplifying devices

The principle of operation and purpose of feedback. Types of feedback. Effect of feedback on the transfer coefficient, input and output impedance of amplifying devices. Stability. Basic circuits of amplifiers with feedback and their characteristics.

5. *Circuitry of operational amplifiers*

Operational amplifiers and their properties. Frequency correction of operational amplifiers. Voltage amplifier. Current amplifier. Adder. Integrator on op-amp. Differentiator on op-amp.

6. *RC- and LC-generators.*

Quartz oscillators. Basic conditions of generation. Meissner oscillator circuits. Hartley oscillator. Colpitts oscillator.

Literature for preparation :

1. Circuitry of analog electronic devices: textbook for universities on educational direction "Radio engineering" / V.N. Pavlov — M.: Academy, 2008.
2. Semiconductor circuit engineering, 12th ed. / U. Tietze and K. Schenk. Publisher: DTK Press. 2008, in 2 volumes. V.1 832p. V.2 942p.

2.4. Digital circuit design

1. *Logical algebra.*

Combination devices. Verbal description. Truth table. Logical function. Circuit implementation. Sequential devices. Verbal description. Truth table. State-transition table. Graph. Logical function. Circuit implementation.

2. *Classification of digital devices. Methods of describing digital devices.*

Combinational devices. Verbal description. Truth table. Logical function. Circuit implementation. Sequential devices. Verbal description. Truth table. State-transition table. Graph. Logical function. Circuit implementation.

3. *Methods of minimizing logical functions.*

Implementation of logical functions using AND, OR, NOT logical elements. Implementation of logical functions using AND-NOT, OR-NOT basic logical elements.

4. *Methodology for synthesizing combinational devices.*

Verbal description. Truth table. Fully and incompletely defined logical functions. Minimization of logical functions. Signal races. Circuit implementation. Multiplexers. Demultiplexers. Adders. Multipliers.

5. *Triggers (flip-flops, latches).*

RS trigger. RCS, T, D, DV, DRS, JK triggers.

6. *Analog-to-digital converters.*

Basic characteristics. Methods of analog-to-digital conversion. Different types of implementations of analog-to-digital converters.

7. *Digital-to-analog converters.*

Basic characteristics. Methods of digital-to-analog conversion. Different types of implementations of digital-to-analog converters.

Literature for preparation :

1. Digital circuitry: textbook for universities on educational direction "Computer science and computing Technics" / Ugryumov E. P. - 3rd ed., [rev . and extra]. - St. Petersburg: BHV - Petersburg , 2010. – 797p. with ill. - Bibliography: pp. 775-780.
2. Semiconductor circuit engineering, 12th ed. / U. Tietze and K. Schenk. Publisher: DTK Press. 2008, in 2 volumes. V.1 832p. V.2 942p.

3. EXAMPLE OF TEST TASKS

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_____/V.V. Loboda/

« ____ » ____ 20 ____ г.

Examples of test assignments (20 questions, 3 points each)

1. Passive electronic component is:

Resistor Capacitor
Inductor Transistor

2. For which networks principle of superpositions is applicable:

For linear and parametric For linear and non-linear
For non -linear and parametric For all

3. Bipolar transistor amplifies and current and voltage

in any configuration mode
in circuit with common
emitter
in circuit with common emitter and in circuit with common base
in circuit with common collector

4. Which of the indicated devices is combinational?

Multiplier
Counter
Register
Trigger

5. Any register It has modes

Write
Store
Read
Reset

Examples of open question (2 questions of 20 points)

1. Amplifier with common drain: fundamental diagram, transmission function, input and output impedance.
2. Combinational digital devices: Adder. Working principle. A circuit on logical elements.

4. CRITERIA FOR ASSESSING THE ENTRANCE EXAMINATION

The entrance examination consists of test tasks reflecting questions on the main sections listed in paragraph 1.

The test tasks are to be completed without the use of auxiliary study materials.

Types of test tasks.

Test tasks can be of the following main types based on the method of response:

- Closed test questions, in which the applicant must choose one or more correct answers from the provided options;
- Open test questions, in which there are no provided correct answers, and the applicant must give the detailed answer independently.

The test questions are divided into two blocks:

Block 1: closed test tasks – 20;

Block 2: open test tasks – 2.

The total score is 100.

Assessment Criteria.

For each correctly solved closed test task, up to 3 points are awarded.

For each correctly solved open task, up to 20 points are awarded.

The response to the open question may include handwritten and explanatory materials. All materials must be combined into a single file before uploading. Illegible, incomplete, unreadable, or damaged files will not be considered by the examination committee.

One of the open questions may require writing a motivational letter. It should be prepared in advance. The motivational letter must include the following information: why you want to study in this master's program; a brief description of the relevance of your thesis that was completed as part of your previous education, and the results obtained; an assessment of how your skills match the requirements of the educational program; information about your professional achievements and links to your publications.