

**RUSSIAN MINISTRY OF EDUCATION AND SCIENCE**  
**SAINT PETERSBURG ELECTROTECHNICAL UNIVERSITY “LETI”**

APPROVED BY:  
DIRECTOR OF THE DEPARTMENT OF EDUCATION  
\_\_\_\_\_ GALUNIN S. A.  
« \_\_\_\_ » \_\_\_\_\_ 2022

**WORKING PROGRAM**  
**DISCIPLINE**  
**« COMPUTING SYSTEMS AND THEIR ELEMENTS »**  
**SPECIALIZATION**  
**2.3.2. - COMPUTING SYSTEMS AND THEIR ELEMENTS**

**SAINT PETERSBURG**  
**2022**

## STRUCTURE DISCIPLINE

Curriculum:

Faculty:

The School of Computer Technologies and Informatics

Department:

The School of Computer Technologies and Informatics

Year

4

Semester

8

### **Activities:**

Lectures

Individual study

### **Type of interim assessment**

Exam (term)

8

The program was considered and approved The School of Computer Technologies and Informatics meeting on 01/04/2022, protocol № 3.

## **SUBJECT SUMMARY**

### **"COMPUTER SYSTEMS AND THEIR ELEMENTS"**

The discipline provides the study of fundamentals and special issues in the field of modern advanced architectural, structural, logical and technical principles of computer systems and their elements.

### **GENERAL POINTS**

1. The study of the principles of operation and characteristics of computing systems built on the basis of promising analog, digital and quasi-digital elements.
2. Formation of skills to carry out theoretical analysis and synthesis, testing and verification of computer systems and their elements using computer simulation, as well as to perform experimental research using specialized tools.

## **CONTENT OF THE DISCIPLINE**

### **Introduction**

The content, purpose and significance of the discipline in the preparation of graduate students, its relationship with other disciplines and the preparation of a PhD thesis.

### **Topic 1. Analog computing devices**

Analog circuits of information processing. Schemes for linear and non-linear information processing. Modern operational amplifiers. The use of an op amp for converting analog signals. Active filters. Sample-hold devices. Promising digital-to-analog and analog-to-digital converters. The use of ADC in analog information input systems.

### **Topic 2. Element base of digital systems**

Logical elements and nodes. Combination and sequence schemes. Methods of analysis and synthesis of functional units. Memory devices: classification, circuitry features. The use of digital elements for the processing of quasi-digital information.

### **Topic 3. Microprocessors and microprocessor systems**

The trend in the development of MP architectures. Harvard and Princeton architecture. Microprocessor command system. Classes of operations, addressing system, command formats. Generalized architecture of microprocessor systems (MPS). Principles of information exchange on a common bus.

MPS memory subsystem. I/O subsystem MPS, serial exchange problems. Interrupt subsystem MPS, radial and vector interrupts. Subsystem of direct access to MPS memory.

### **Topic 4. FPGAs and systems on a chip**

Programmable logic microcircuits of different levels of integration (SPLD, CPLD, FPGA, SOPC), analog programmable circuits. Methods for designing functional and microsystem devices, as well as analog elements of information preprocessing. Hard- and soft-cores, memory, high-performance means of information transfer.

Language tools for designing and verifying computer systems on a chip, methods for designing a test environment using the principles of object-oriented programming,

mechanisms for random generation of test signals within given constraints. Features of the system level of designing systems on a chip.

### **Topic 5. Automation of technological design of micro-systems**

Methods for designing custom microsystems on a VLSI chip: structural topological organization and operation of large VLSI fragments (macroblocks), industrial CMOS circuitry, express analysis, optimization and calculation of circuit characteristics with restoration of parasitic parameters from topology.

### **Topic 6. Hardware and software systems for signal and image processing**

Basic signal and image processing algorithms; architecture of modern digital signal processors; interactive environment for developing and debugging programs for the DSP processor platform using C programming languages, assembler and libraries of hardware-oriented functions; organization of the process of digital processing of signals and images in real time on the platform of the DSP processor from Texas Instruments.

### **Conclusion**

Prospects for the development of the element base of computing systems.

If the discipline is implemented in groups with a small number, classes in individual sections can take the form of an orientation lecture, the issuance and explanation of 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 on the implementation of individual tasks are available to the graduate student in printed or electronic form (on the University's 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 dissertation research of the postgraduate student within the framework of the studied discipline.

## METHODOLOGICAL SUPPORT FOR THE DISCIPLINE

### The list of basic and additional academic literature necessary for mastering the discipline

№	Name, bibliographic description	Number of copies in library (on department)
1	Ugryumov, E. P. Digital circuitry: textbook. allowance for universities in the direction of subnotes. 230100 "Computer science and computer technology" / E.P. Ugryumov. - 3rd ed., revised. and additional - St. Petersburg. : BHV-Petersburg, 2010. - 797 p. : ill. 61	61
2	Mursaev, A. Kh. Workshop on designing in VerilogHDL and SystemVerilog languages: [Electronic resource]: tutorial / A. Kh. Mursaev, O. I. Bureneva. - 2nd ed., erased. - St. Petersburg: Lan, 2018. - 120 p. Electronic resource	Электронный ресурс
3	Ugryumov, E. P. Programmable components of devices and systems on a chip: [Electronic resource]: textbook. allowance / E. P. Ugryumov; St. Petersburg State Electrotechnical University. IN AND. Ulyanov (Lenin) "LETI". - Electron. text data. - St. Petersburg. : Publishing House of St. Petersburg Electrotechnical University "LETI", 2013. - 1 el. opt. disc (CD-ROM). Electronic resource	Электронный ресурс
4	Bureneva, OI Components and structures of processor systems on a crystal: textbook. allowance / O. I. Bureneva, E. P. Ugryumov; St. Petersburg State Electrotechnical University. IN AND. Ulyanov (Lenin) "LETI". - St. Petersburg. : SPbGETU "LETI", 2014. - 127, [1] p. : ill., tab. - Bibliography: p. 126.64	64
5	Zuev, I. S. Designing specialized silicon compilers in CAD TRAS: [Electronic resource]: electron. textbook allowance / I. S. Zuev, N. M. Safyannikov; St. Petersburg State Electrotechnical University. IN AND. Ulyanov (Lenin) "LETI". - Electron. text data. - St. Petersburg. : Publishing house of St. Petersburg Electrotechnical University "LETI", 2019. Electronic resource	Электронный ресурс

6	Designing digital LSI fragments on complementary MOS structures: textbook. allowance / I. S. Zuev, N. M. Safyannikov; St. Petersburg State Electro-Technical University. IN AND. Ulyanov (Lenin) "LETI". - St. Petersburg. : Publishing House of St. Petersburg Electrotechnical University "LETI", 2018. - 120 p. 44	44
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**The list of information "Internet" resources used in the development of the discipline**

№	URL
1	<a href="https://kit-e.ru/">https://kit-e.ru/</a>
2	<a href="https://www.intel.com">https://www.intel.com</a>

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

Specific forms and procedures for current knowledge control and intermediate certification including the list of examination questions (Appendix 1), as well as methodological guidelines for students to work independently in mastering disciplines are brought to the attention of students during the first weeks of training.

The list of examination questions on the discipline  
"COMPUTER SYSTEMS AND THEIR ELEMENTS"

1. Analogue information processing circuits. Schemes for linear and non-linear information processing.
2. Modern operational amplifiers. The use of an op amp for converting analog signals.
3. Active filters.
4. Sample-and-hold devices.
5. Promising digital-to-analog and analog-to-digital converters. The use of ADC in analog information input systems.
6. Combination and sequential schemes.
7. Methods of analysis and synthesis of functional units.
8. Memory devices: classification, circuitry features.
9. The use of digital elements for the processing of quasi-digital information.
10. The trend of development of MP architectures. Harvard and Princeton architecture.
11. Microprocessor command system. Classes of operations, addressing system, command formats.
12. Generalized architecture of microprocessor systems (MPS). Principles of information exchange on a common bus.
13. MPS memory subsystem.
14. Input/output subsystem MPS, problems of sequential exchange.
15. Interrupt subsystem MPS, radial and vector interrupts.
16. Subsystem of direct access to the MPS memory.
17. Programmable logic microcircuits of different levels of integration (SPLD, CPLD, FPGA, SOPC). Аналоговые программируемые схемы.
18. Methods for designing functional and microsystem devices, as well as analog elements of information pre-processing.



19. Hard- and soft-kernels, memory, high-performance means of information transmission.
20. Language tools for designing and verifying computing systems on a chip, methods for designing a test environment using the principles of object-oriented programming, mechanisms for random generation of test signals within given constraints.
21. Features of the system level of designing systems on a crystal.
22. Methods for designing custom microsystems on a VLSI chip.
23. Basic signal and image processing algorithms; architecture of modern digital signal processing processors.