Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Educational Institution of Higher Education
**Perm National Research Polytechnic University**

**APPROVED BY**
Pro-rector for Academic Affairs
_____ N.V. Lobov
"25" 11 2021

# ACADEMIC COURSE WORKING PROGRAM

**Academic course:** Electronic Devices of Mechatronic and Robotic Systems (Module Robotics in Automated Production)
(Name)

**Form of education:** Full-time
(full-time / part-time / correspondence)

**Level of higher education:** Bachelor's program
(Bachelor's program / Specialist program / Master's program)

**Total labour intensiveness:** 108 (3)
(Hours (CU))

**Training program (degree):** 15.03.06 Mechatronics and Robotics
(Code and denomination of degree)

**Direction:** Mechatronics and Robotics
(Title of curriculum)

Perm 2021

## 1 General Provisions

### 1.1 Goals and Objectives of the Course

The goal of the course is mastering systematic theories, special knowledge and skills of fields including electrical engineering, the analysis of electronic circuits, the application of electronic devices in the development of technical automation, and conducting research for high-efficient management, control and testing of robotic systems.

The objectives of the course are:

- to study generalized structures, interconnections (interactions) of electronic devices and blocks of robotic systems;
- to study the physical fundamentals of power semiconductor and microelectronics devices;
- to study the functional electronic parts of microelectronics and their applications in robotic systems;
- to form the ability to apply methods of optimal solutions in mechatronic modules and robotic systems design;
- to apply possible circuit solutions for electronic devices in robotic systems.

### 1.2 Prescribed Objects of the Course

Functional parts of robotic technological complexes and systems

### 1.3 Starting Conditions

Unstipulated

## 2. Planned Results of the Course Training

| Competence | Indicator's Index | Planned Results of the Course Training (to know, to be able to, to master) | Indicator of Attaining Competence which the planned results of training are correlated with | Means of Assessment |
|---|---|---|---|---|
| **GPC-11** | **IA-1$_{GPC-11}$** | **To know** the principles of operation and mathematical description of robotics systems components (electronic elements and computer equipment). | **Knows** methods and software tools for designing devices and subsystems of mechatronic and robotic systems. | Test |
| **GPC-11** | **IA-2$_{GPC-11}$** | **To be able to** apply modern tools and software to solve engineering problems in the development, production and operation of modern robotic devices and systems. | **Is able to** apply software tools for the development of hardware and software for mechatronic and robotic systems. | Test |
| **GPC-11** | **IA-3$_{GPC-11}$** | **To master the skills** of applying experimental research methods in creation of robotic devices and systems. | **Has mastered the skills** of using standard actuators and control devices, automation tools, measuring equipment for the creation of devices and systems of mechatronics and robotics. | Test |

| | | | | |
|---|---|---|---|---|
| **RPC-1** | **IA-1$_{RPC-1}$** | **To know** the methods of theoretical and experimental research, methods of calculating the electric circuits of analog and digital electronic devices. | **Knows** methodology of scientific research, methods of mathematical models of mechatronics' and robotics' processes and objects. | Test |
| **RPC-1** | **IA-2$_{RPC-1}$** | **To be able to** apply simulation methods of processes and objects of robotic systems. | **Is able to** summarize, analyze and systematize information for the preparation of analytical reviews on a given topic, use standard software tools for mathematical modeling of processes and objects of mechatronics and robotics. | Test |
| **RPC-1** | **IA-3$_{RPC-1}$** | **To master the skills** of planning and carrying out analytical, simulation and experimental research of robotic tools and systems, critical evaluation of theoretical and experimental data. | **Has mastered the skills** of independent study, critical reflection and systematization of scientific and technical information, conducting theoretical research and computational experiments in accordance with the use of selected standard software tools. | Test |

## 3 Full time and forms of academic work

| **Form of academic work** | **Hours in all** | **Distribution in hours according to semesters** |
|---|---|---|
| | | **Number of semester** |
| | | 5 |
| 1 Holding classes (including results monitoring) in the form:<br>1.1 Contact classwork, including: | 54 | 54 |
| - lectures (L) | 18 | 18 |
| - laboratory work (LW) | 16 | 16 |
| - practice, seminars and/or other seminar-type work (PW) | 16 | 16 |
| - control of self-work (CSW) | 4 | 4 |
| - test | | |
| 1.2 Students' self-work (SSW) | 54 | 54 |
| 2 Intermediate attestation | | |
| Exam | | |
| Grading test | | |
| Test (Credit) | 9 | 9 |
| Course Project (CP) | | |
| Course Work (CW) | | |
| **Workload in hours** | **108** | **108** |

## 4 Course contents

| **Name of the units with the course outline** | **Full time of classroom** | **Full time of** |
|---|---|---|

| | activity in hours according to the forms | | | extracurricular work in hours according to the forms |
|---|---|---|---|---|
| | **L** | **LW** | **PW** | **SSW** |
| 5th semester | | | | |
| Electronic devices and their application in mechatronic systems. | 2 | 0 | 0 | 2 |
| Structure of a mechatronic system with computer control. A general electronic device model of mechatronic system. Electronic components design of an electromechanical module of mechatronic system. | | | | |
| Hardware components and typical electronic parts of control systems. | 4 | 4 | 4 | 12 |
| Main types of diodes. Semiconductor optoelectronic devices. Transistors. Thyristors. | | | | |
| Electronic devices of energy channels and control systems. | 2 | 0 | 2 | 6 |
| Electronic parts of digital single-loop control systems in an electric drive. Features of electronic devices in control systems of electric drives. | | | | |
| Functional microelectronic devices of control systems. | 4 | 4 | 4 | 12 |
| Operational amplifiers. Electronic components of control systems with optical information transmission. ADC and DAC control systems. | | | | |
| Features of power electronic devices. | 2 | 4 | 2 | 10 |
| Power electronic actuating devices. Electronic components for generating pulses of controlling key elements. Impulse converters of constant voltage. Electronic rectifiers. Electronic inverters. | | | | |
| Application of electronic circuit control devices. | 4 | 4 | 4 | 12 |
| Thyristor controlled electrical drives. Transistor frequency converters. Electric drive with pulse-width converter. Pulse power sources in control systems. | | | | |
| **Total with regard to 5th semester** | **18** | **16** | **16** | **54** |
| **Total with regard to the course** | **18** | **16** | **16** | **54** |

## Topics of exemplary practical works

| № | Topic of practical works |
|---|---|
| 1 | Electrical conductivity of semiconductors. Properties of a PN junction in a semiconductor. |
| 2 | Pulse and power diodes, stabilitrons, varicaps, and Schottky diodes. |
| 3 | Bipolar and field-effect transistors: physical basis of work, characteristics. |
| 4 | Tunable light sources and elements based thereon. |
| 5 | Examples of op-amp-based scaling, integrating, differentiating, and logarithmic devices. Comparators, limiters, and active filters. |
| 6 | Autogenerators of harmonic oscillation, their purpose, construction principles; RC and LC-type generators. |
| 7 | Functional power supply elements: AC voltage converters, parametric DC stabilizers. |
| 8 | Frequency inverter power supplies. |

Topics of exemplary laboratory works

| № | Topic of laboratory works |
|---|---|
| 1 | The key elements of the electronic devices (diodes, transistors, thyristors). |
| 2 | Study of electronic devices (operational amplifier, ADC and DAC). |
| 3 | Study of electronic devices (straighteners, inverters). |
| 4 | Digital control of thyristor electric drive. |
| 5 | Transistor frequency converters. |
| 6 | Electric drive with a pulse-width converter. |

## 5 Organizational and Pedagogical Conditions

### 5.1 Educational Technologies Used for Competences Formation

Holding lectures in the discipline is based on the active method of training in the process of which students are not passive but active participants of the lesson answering questions of the teacher. Teacher's questions are aimed at activating the process of learning material as well as at the development of logical thinking. The questions stimulating associative thinking and connecting new material with the previous one are formulated by the teacher in advance.

Practical lessons are held by realization of the method based on active training: problem areas are determined, groups are formed. The following aims are pursued in the process of practical education: use of definite disciplines knowledge and creative methods in solving problems and decision-making; students' skill-building of teamwork, interpersonal communication and development of leadership skills; consolidation of the basic theoretical knowledge.

Laboratory classes are based on an interactive learning method in which students communicate not only with the teacher but also with each other. At the same time, students' activity in the learning process dominates. The teacher's place in interactive classes is reduced to orienting students' activities to achievement of the goals of studies.

Interactive lectures, group discussions, role-playing games, training sessions, and analysis of situations and simulation models are used in academic studies.

### 5.2 Students' Manual for the Course Study

Learning the course, it is advisable for students to implement the following recommendations:

1. Learning of the discipline should be done systematically.
2. After learning one of the course units with the help of the text-book or lecture notes it is recommended to reproduce the basic terms, definitions, notions of the unit from memory.
3. Special attention should be paid to the reports on practical studies and individual complex tasks for self-work.
4. The topics list for individual study is given by the teacher at the lectures. The teacher also provides students with literary sources (first of all, new ones in the periodical scientific literature) for a more detailed under-standing of the issues presented at the lectures.

## 6 List of Teaching Materials and Information Supply for Students' Self work in the Discipline

### 6.1 Paper-based courseware

| № | Bibliographic entry (author, title, mode of publication, place, publishing house, year of publication, number of pages) | Number of copies in the library |
|---|---|---|
| | **1 Basic literature** | |
| 1 | Zhmud V.A. Numerical Optimization of Regulators for Automatic Control System : textbook for higher education / Zhmud V.A., | |

| | | |
|---|---|---|
| | Dimitrov L.V., Nosek J. NSTU, 2019, 296 p. | |
| **2 Additional literature** | | |
| **2.1 Educational and scientific literature** | | |
| 1 | Karsa B.E.F. Electrical Measuring Instruments and Measurements. Budapest : Akademiai Kiado, 1967. 827 p. | |
| 2 | Dobos D. Electronic Electrochemical Measuring Instruments. 2 ed. Budapest : Terra, 1966. 449 p. | |
| | | |
| **2.2 Standardized and Technical literature** | | |
| | | |
| **3 Students' manual in mastering discipline** | | |
| | | |
| **4 Teaching and learning materials for students' self-work** | | |
| | | |

## 6.2 Electronic Courseware

| Kind of literature | Name of training tool | Reference to information resource | Accessibility of EBN (Internet / local net; authorized / free access ) |
|---|---|---|---|
| Additional literature | Sandler B-Z. Robotics: designing the mechanisms for automated machinery | http://www.robot.bmstu.ru/files/books/[Robotic]%20Robotics%20-%20Designing%20the%20Mechanisms%20-%20Ben-Zion%20Sandier.pdf | internet, free access |

## 6.3 License and Free Distributed Software used in the Course Educational Process

| Type of Software | Software branding |
|---|---|
| Operating systems | Windows 10 (Azure Dev Tools for Teaching) |
| Office applications | Microsoft Office Professional 2007, license 42661567 |

## 6.4 Modern Professional Databases and Inquiry Systems Used in the Course Educational Process

| Branding | Reference to information resource |
|---|---|
| Scientific electronic library database (eLIBRARY.RU) | https://elibrary.ru/ |
| Scientific Library of Perm National Research Polytechnic University | http://lib.pstu.ru/ |
| Lan' Electronic library system | https://e.lanbook.com/ |
| Information resources of the Network ConsultantPlus | http://www.consultant.ru/ |

## 7 Logistics of the Course Educational Process

| Type of classes | Name of the necessary basic equipment | Number of units |
|---|---|---|
| Laboratory class | Personal computer | 25 |
| Lecture | Projector, laptop | 1 |
| Practical class | Personal computer | 25 |

## 8 Fund of the Course Evaluating Tools

| Described in a separate document |
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