**NJSC «Kazakh National Research Technical University named after K.Satpayev»**
**Institute of Industrial Automation and Digitalization**
**Automation and Control Department**

# CURRICULUM PROGRAM

## «AUTOMATION AND ROBOTIZATION»
## Bachelor of Engineering and Technology
## in the field of automation, robotization, artificial intelligence and digitalization of production

1st edition
in accordance with the State Educational Standard of Higher Education 2018

**Almaty 2021**

The program is compiled and signed by the parties:

from KazNITU named after K.I. Satpayev:

1. Head of the Department of Automation and Control (AaC), Candidate phys.-math. Sciences — N.U. Aldiyarov

2. Director of Institute of Industrial Automation and Digitalization (IIAD), PhD — B.O. Omarbekov

3. Chairman of the educational-methodical group of the Department of AaC, Doctor of Technical Sciences, Professor — B.A. Suleimenov

From employers

Deputy Director Saiman Corporation LLP — K.I. Baybekov

Approved at the meeting of the Academic Council of the Kazakh National Research Technical University named after K.I. Satpayev, (protocol No.3 th June 25 , 2021)

**Qualification:**

Level 6 of the National Qualifications Framework:

6B071 Engineering (Bachelor).

**Professional competencies:** Automation, robotization, artificial intelligence and digitalization of production.

## 1 Brief program description

The direction of the program of specialty and specialization covers engineering.

The purpose of the educational program is to teach students general educational, basic and core disciplines with the achievement of relevant competencies.

The tasks and the content of the EP are given in section 9 "Description of disciplines".

In case of successful completion of the full bachelor's course, the graduate is awarded with the academic degree of “Bachelor of Engineering and Technology in the Field of Automation and Robotization”.

The undergraduate educational program “Automation and Robotization” differs from the existing educational program on the specialty 5B070200 - “Automation and Control” by a complete update of the internal content of the disciplines related to the automation of technological processes and digitalization of production and by the addition of disciplines on the robotization of production processes. In a number of disciplines of these two areas, there has been proposed a new content with the inclusion of approaches based on artificial intelligence methods.

The educational program has increased the volume of mathematical, natural science, basic and language disciplines. Added core disciplines that can be divided into three groups: disciplines on automation, disciplines on robotization and digitalization of production on the application of artificial intelligence methods. The result was an educational program that has innovative content and is aimedat implemention the state program "Digital Kazakhstan" and the strategy of Industry 4.0.

The educational program provides the study of the following innovative disciplines:

- automation and control in technical and robotic systems;
- design of automation and robotization systems;
- intellectual systems of technological process control;
- intellectual and information systems for technological equipment diagnostics;
- robotization of production processes;
- automation of typical technological processes and production;
- operational control of production;
- programming of controllers and microcontrollers;
- installation and adjustment of automation systems;
- installation and adjustment of electrical systems.

During the process of mastering the educational program, the bachelor of engineering and technology in the field of automation and robotization should have the following key competencies.

The bachelor must:

*have an idea:*

- about modern automated digitaltechnological process control systems and about robotic technological complexes;

- about modern approaches to the use of software for comparative analysis and evaluation of automation and robotization systems, including the use of artificial intelligence methods;

- about modern technical support of automation and robotization systems (sensors, actuators, microcontrollers, specialized microprocessors, etc.);

*know:*

- methods for the creation functional diagrams of automated technological process control and robotic systems in various industries;

- current trends in the development of technical support systems for automation and robotization of production processes;

- standards, methodological and regulatory materials accompanying the operation, installation and adjusting of automated control systems and robotic technological complexes in various industries;

*be able to:*

- conduct a comparative analysis and evaluation of automation and robotization systems using modern software products and mathematical models;

- use modern algorithmic and software support for the synthesis of microprocessor-based automation and robotization systems of specific production processes;

*have skills in:*

- organization of works on the operation, installation and adjusting technical means of automation and robotization systems of production processes;

- organization of works on the collection, storage and processing of information used in the field of professional activity.

The professional activity of the graduates of the program is directed to the field of automation, robotization, artificial intelligence and automated control.

The objects of professional activity of a bachelor are: automated control systems for technological processes of various industries, automated information and control systems for various purposes, automated systems for receiving, processing and transmitting data for various purposes, automated design systems for systems, objects, devices.

The types of professional activity are:

In the field of organizational and managerial activities: to be the head of the group of the subdivision for the operation, repair of elements, devices of automated control systems and robotic technological complexes in various industries;

In the field of experimental research activities: to be a specialist in experimental research of objects of automation and robotization of industrial production;

In the field of research activities: to be an engineer in a scientific laboratory for the research and development of modern automated control systems and robotic technological complexes in various industries;

In the field of design and development activities: to be an engineer for the development and design of automated control systems and robotic technological complexes in various industries.

The subjects of the professional activity of the bachelor are: development, creation and operation of automated production systems; methods of analysis, forecasting and control of technological processes, technical systems and research facilities of high technologies. Specific types of professional activities, for which a bachelor is mainly prepared, are determined by the higher educational institution together with the research and teaching staff of the higher educational institution and employers' associations.

During theeducational processthere are provided production practices at such enterprises as: “Verbulak” LLP, “Siemens-Kazakhstan” LLP, “ASUTP-Honeywell” LLP, “NAT Kazakhstan” JSC, “Kazatomprom” JSC, “Kazzinc” LLP, “Kazphosphate MU” LLP, “Karachaganak Petroleum Operating"and others.

## 2 Entry Requirements

Admission to the university is carried out according to the applications of the applicant who has completed secondary, secondary special education on a competitive basis in accordance with the points of the certificate issued on the results of the unified national test with a minimum score of at least 65 points.

Special requirements for admission to the program are applied to graduates of 12–years schools, colleges, applied baccalaureate programs, NIS, etc. Such applicants must undergo diagnostic test on English, mathematics, physics and special disciplines.

Rules for recredit for accelerated (reduced) training on the basis of 12-years secondary, secondary technical and higher education

| Code | Type of competence | Description of competence | Result of competence | Responsible person |
|---|---|---|---|---|
| GENERAL (Implies full education with possible additional ones depending on the level of knowledge) | | | | |
| G1 | Communication skills | - Fluent monolingual oral, written and communication skills<br>- ability of not fluent communication with a second language<br>- Ability to use communication in different situations<br>- to have the basics of academic writing on native language<br>- language level diagnostic test | Full 4-year study with obtaining at least 240 academic credits (including 120 contact auditorial academic credits) with possible recredit on the second language where students have advanced level. The language level is determined by a diagnostic test. | Department of Kazakh and Russian languages, Department of English language |
| G2 | Mathematical literacy | - Basic mathematical intellect at the communication level<br>- the ability to solve situational problems based on the mathematical apparatus of algebra and the beginning of mathematical analysis<br>- diagnostic test on mathematical literacy in algebra | Full 4-year study with obtaining at least 240 academic credits (including 120 contact auditorial academic credits). If the diagnostic test is passed good, the mathematics level is 1, if it is unsatisfactory - the algebra level and the beginning of analysis | Department of Mathematics |
| G3 | Basic Literacy in Natural Sciences | - a basic understanding of the scientific picture of the world with an understanding of the essence of the basic laws of science<br>- understanding of basic hypotheses, laws, methods, formulation of conclusions and assessment of errors | Full 4-year study with obtaining at least 240 academic credits (including 120 contact auditorial academic credits). If the diagnostic test is passed good, the physics level is 1, General chemistry, with unsatisfactory result - the level of the Beginning of | Department in the areas of natural sciences |

| | | | | |
|---|---|---|---|---|
| | | | Physics and the Basic Foundations of Chemistry | |
| SPECIFIC (implies reduced education due to the recredit depending on the level of knowledge on competencies for graduates of 12-years schools, colleges, universities, including humanitarian and economic areas) | | | | |
| S1 | Communication skills | - Fluent bilingual oral, written and communication skills<br>- ability of not fluent communication with a third language<br>- writing skills of different styles and genres<br>- skills of deep understanding and interpretation of own work of a certain level of complexity (essay)<br>- basic aesthetic and theoretical literacy as a condition for full perception, interpretation of the original text | Full recredit on languages (Kazakh and Russian) | Department of Kazakh and Russian languages |
| S2 | Mathematical literacy | - Special mathematical intellect using induction and deduction, generalization and concretization, analysis and synthesis, classification and systematization, abstraction and analogy<br>- ability to formulate, substantiate and prove provisions<br>- the use of general mathematical concepts, formulas and extended spatial perception for mathematical problems<br>- complete understanding of the basics of mathematical analysis | Recredit on the discipline Mathematics(Calculus) I | Department of Mathematics |
| S3 | Special literacy in natural sciences (Physics, Chemistry, Biology and Geography) | - A broad scientific perception of the world, a fundamental understanding of natural phenomena<br>- critical perception for understanding the phenomena of the world<br>- cognitive abilities to formulate a scientific understanding of the forms of matter existence, its interaction in nature | Recredit on Physics I, General Chemistry, General Biology, Introduction to Geology, Introduction to Geodesy; Educational practice, etc. | Department in the areas of natural sciences |

| | | | | |
|---|---|---|---|---|
| S4 | English language | - readiness for further self-study in English in various fields<br>- readiness to gain experience in project and research work using English language | Recredit on English language above academic level to professional ones (up to 15 credits) | Department of English language |
| S5 | Computer skills | - Basic programming skills in one modern language<br>- use of software and applications for teaching various disciplines | Recredit on the discipline Introduction to information and communication technologies, Information and communication technologies | Department of Software Engineering |
| S6 | Socio-humanitarian competences and behavior | - understanding and perception of the responsibility of every citizen for the development of the country and the world<br>- ability to discuss ethical and moral aspects in society, culture and science. | Recredit on Modern history of Kazakhstan (except for the state exam) | Department of Social disciplines |
| | | - critical understanding and ability to debate for debating on modern scientific hypotheses and theories. | Recredit on philosophy and other humanitarian disciplines | |
| PROFESSIONAL (implies reduced education due to recredit depending on the level of knowledge on competencies for college graduates, AV schools, universities) | | | | |
| P1 | Professional competencies | - critical perception and depth understanding of professional competencies at level 5 or 6<br>- ability to discuss and argue on professional issues within the framework of the mastered program | Recredit on basic professional disciplines, including introduction to the specialty, engineering ethics, technology of robotic production, technological objects of automation, theoretical foundations of electrical engineering, technological measurements and devices, mathematical principles of control theory, electronic automation devices. | Graduate department |
| P2 | General engineering competence | - basic general engineering skills and knowledge, ability to solve general engineering tasks and problems<br>- be able to use application packages for experimental data processing, solving systems of algebraic and differential equations | Recredit on general engineering disciplines (engineering graphics, descriptive geometry, fundamentals of electrical engineering, fundamentals of microelectronics.) | Graduate department |
| P3 | Computer engineering competence | - basic skills of using computer programs and software systems for solving general engineering tasks | Recredit on the discipline of computer graphics, computer modeling and programming in the MatLab environment | Graduate department |

| | | | | |
|---|---|---|---|---|
| P4 | Socio-economic competence | - critical understanding and cognitive abilities to argue on modern social and economic issues<br>- a basic understanding of the economic evaluation of objects of study and projects profitability. | Recredit on social and humanitarian and technical and economic disciplines for the elective cycle credit | Graduate department |

The university may refuse to recredit if a low diagnostic level is confirmed or on the completed disciplines the final grades were lower than A and B.

## 3 Requirements to complete the course and receive a diploma

Generally compulsory standard requirements for graduation and assignment of an academic degree of bachelor: mastering at least 256 academic credits of theoretical studies and the final dissertation work or the state exam on the specialty.

Special requirements for graduation on this program

*graduate should know:*

- methods of synthesis of automatic control systems and automated process control.
- methods for the creation functional diagrams of automated process control systems and robotic systems in various industries;
- current trends in the development of technical support systems for automation, digitalization and robotization of production processes;
- standards, methodological and regulatory materials accompanying the operation, installation and adjustment of automated control systems and robotic technological systems in various industries;

*graduate must be able to:*

- conduct a comparative analysis and evaluation of automation, digitalization and robotization systems of production processes using modern software products and mathematical models;
- program microcontrollers and create programs in high-level languages;
- use modern algorithmic and software support for the synthesis of microprocessor-based automation, digitalization and robotization systems of production processes;
- conduct the design, installation, adjustment and maintenance of technical means of automation and robotization systems.

The educational process on this EP is competed by passing the state exam on the following disciplines or by passing the dissertation work before the MCCof the diploma project (work).

# 4 The curriculum of the educational program

MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K. I. SATPAYEV

SATBAYEV UNIVERSITY

APPROVED
Rector of KazNRTU named after K. I. SATPAYEV
M.Kh. Ikhsanov
"25" 06 2021 y.

**WORKING CURRICULUM** for 2021-2022 academic year admission
*Educational program 6B07103 - "Automation and Robotization"*
*Group of Educational programs B063 - "Electrical engineering and automation"*

Full-time study | Study duration : 4 years | Academic degree: bachelor of engineering and technology

| Year of study | Code | Name of discipline | Cycle | Credits | Total hours | /ISW | SRS (including SRSP), in hours | pre-requisites |
|---|---|---|---|---|---|---|---|---|
| | | 1 semester (fall 2021) | | | | | | |
| 1 | LNG108 | English | G | 5 | 150 | 0/0/3 | 105 | Diagnosti |
| | LNG104 | Kazakh (Russian) language | G | 5 | 150 | 0/0/3 | 105 | Diagnosti |
| | KFK101 | Physical education I | G | 2 | 60 | 0/0/2 | 30 | |
| | HUM100 | Modern history of Kazakhstan | G | 5 | 150 | 1/0/2 | 105 | |
| | HUM128 | Political science | G | 2 | 60 | 1/0/0 | 45 | |
| | GEN177 | Engineering and computer graphics | B | 5 | 150 | 1/1/1 | 105 | |
| | PHY111 | Physics I | B | 5 | 150 | 1/1/1 | 105 | |
| | MAT101 | Mathematics I | B | 5 | 150 | 1/0/2 | 105 | |
| | | Total: | | 34 | | | | |
| | | 3 semester (fall 2022) | | | | | | |
| 2 | CHE452 | Ecology and sustainable development | G | 2 | 60 | 1/0/0 | 45 | |
| | HUM127 | Sociology | G | 2 | 60 | 1/0/0 | 45 | |
| | CSE677 | Information and Communication technology | G | 5 | 150 | 2/1/0 | 105 | |
| | KFK103 | Physical education III | G | 2 | 60 | 0/0/2 | 30 | KFK102 |
| | MAT103 | Mathematics III | B | 5 | 150 | 1/0/2 | 105 | MAT102 |
| | ELC541 | Theoretical Foundations of Electrical Engineering | B | 5 | 150 | 2/1/0 | 90 | |
| | AUT423 | Computer modeling and programming in MatLab | B | 5 | 150 | 1/2/0 | 105 | |
| | 2201 | Elective | B | 5 | 150 | | 105 | |
| | | Total: | | 31 | | | | |
| | | 5 semester (fall 2023) | | | | | | |
| 3 | 3203 | Elective | B | 5 | 150 | | 105 | |
| | 3204 | Elective | B | 5 | 150 | | 105 | |
| | 3205 | Elective | B | 5 | 150 | | 105 | |
| | 3206 | Elective | B | 3 | 150 | | 105 | |
| | ROB506 | Integral and microprocessor circuit design | S | 5 | 150 | 2/1/0 | 105 | |
| | AUT411 | Linear System of Automatic Control | S | 5 | 150 | 1/1/1 | 90 | |
| | | Total: | | 28 | | | | |
| | | 7 semester (fall 2024) | | | | | | |
| 4 | 4211 | Elective | B | 5 | 150 | | 105 | |
| | AUT408 | Intelligent process control systems | S | 5 | 150 | 1/2/0 | 105 | |
| | 4302 | Elective | S | 5 | 150 | | 105 | |
| | 4303 | Elective | S | 5 | 150 | | 105 | |
| | 4304 | Elective | S | 5 | 150 | | 105 | |
| | 4305 | Elective | S | 3 | 90 | | 60 | |
| | | Total: | | 28 | | | | |

| Code | Name of discipline | Cycle | Credits | Total hours | /ISW | SRS (including SRSP), in hours | pre-requisites |
|---|---|---|---|---|---|---|---|
| | 2 semester (spring 2022) | | | | | | |
| LNG108 | English | G | 5 | 150 | 0/0/3 | 105 | LNG105 |
| LNG104 | Kazakh (Russian) language | G | 5 | 150 | 0/0/3 | 105 | LNG107 |
| KFK102 | Physical education II | G | 2 | 60 | 0/0/2 | 30 | KFK101 |
| HUM129 | Culturology | G | 2 | 60 | 1/0/0 | 45 | |
| MAT102 | Mathematics II | B | 5 | 150 | 1/0/2 | 105 | MAT101 |
| PHY112 | Physics II | B | 5 | 150 | 1/1/1 | 105 | PHY111 |
| CHE495 | Chemistry | B | 5 | 150 | 1/1/1 | 105 | |
| | Total: | | 29 | | | | |
| | 4 semester (spring 2023) | | | | | | |
| MNG487 | Fundamentals of Entrepreneurship, Leadership and Anti-corruption culture | G | 3 | 90 | 1/0/1 | 60 | |
| HUM132 | Philosophy | G | 5 | 150 | 1/0/2 | 105 | |
| CHE451 | Life safety | G | 2 | 60 | 1/0/0 | 45 | |
| KFK104 | Physical education IV | G | 2 | 60 | 0/0/2 | 30 | AAP122 |
| AUT413 | Mathematical Foundations of control theory | B | 5 | 150 | 2/0/1 | 105 | |
| ROB502 | Basics of Electronics | B | 5 | 150 | 1/1/1 | 90 | |
| 2202 | Elective | B | 5 | 150 | | 105 | |
| | Total: | | 29 | | | | |
| | 6 semester (spring 2024) | | | | | | |
| 3207 | Elective | B | 5 | 150 | | 105 | |
| 3208 | Elective | B | 5 | 150 | | 105 | |
| 3209 | Elective | B | 5 | 150 | | 105 | |
| 3210 | Elective | B | 5 | 150 | | 105 | |
| AUT416 | Nonlinear system of the automatic control | S | 5 | 150 | 1/1/1 | 105 | |
| 3301 | Elective | S | 3 | 90 | | 60 | |
| | Total: | | 28 | | | | |
| | 8 semester (spring 2025) | | | | | | |
| 4306 | Elective | S | 5 | 150 | | 105 | |
| 4307 | Elective | S | 5 | 150 | | 105 | |
| 4308 | Elective | S | 5 | 150 | | 105 | |
| ECA003 | Preparation and writing of the thesis (project) | FA | 6 | | | | |
| ECA103 | Graduate thesis (project) defense | FA | 6 | | | | |
| | Total: | | 27 | | | | |

| Year of study | Code | Name of discipline | Cycle | Credits | Semester |
|---|---|---|---|---|---|
| | | Obligatory education with P/NP assessment | | | |
| 1 | AAP101 | Educational Internship (B) | B | 2 | 2 |
| 2 | AAP174 | Industrial internship I (S) | S | 2 | 4 |
| 3-4 | AAP195 | Industrial internship II (S) | S | 4 | 6 |
| | | Other education | | | |
| 1 | AAP107 | Physical education III, IV | G | 0 | 3-7 |
| 2-3 | AAP500 | Military training | G | 0 | 3-6 |

Total number of credits

| Cycle of disciplines | Credits: compul-sary | elective | practice | total |
|---|---|---|---|---|
| Cycle of general disciplines (G) | 51 | 7 | 0 | 58 |
| Cycle of basic disciplines (B) | 55 | 53 | 4 | 112 |
| Cycle of special disciplines (S) | 20 | 36 | 4 | 60 |
| Total of theoretical study | 126 | 96 | 8 | 230 |
| Final attestation (FA) | 12 | 0 | 12 | 12 |
| OVERALL | 138 | 96 | 20 | 242 |

Decision of the Academic Council KazNRTU named after K. I. SATPAYEV. Minutes № 3, dated "25" 06 2021
Decision of the Academic Council of the Institute of Industrial Automation and Digitalization. Minutes № 12, dated "03" 06 2021

Vice-rector for academic affairs — B.A. Zhautikov
Institute Director
Head of Department "Automation and Control" — N.U. Aldiyarov
Representative of Specialty council+A41:R78 — S.K. Abdigaliyev

MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K. I. SATPAYEV

APPROVED
Director of the Institute of Industrial
Automation and Digitalization
_____ B.O. Omarbekov
«03» 06 2021

ELECTIVE DISCIPLINES SPECIALITIES for recruitment for the 2021-2022 academic year
Educational program 6B07103 - "Automation and robotization"
Group of educational programs B063 - "Electrical Engineering and Automation"

Form of study: full-time | Study period: 4 years | Academic degree: Bachelor of Engineering and Technology

| Year of study | Curriculum elective code | Discipline Code | Name of disciplines | Cycle | ESTS | Credits | lec/lab/pr | pre-requisites |
|---|---|---|---|---|---|---|---|---|
| | | | 3 semester | | | | | |
| 2 | 2201 | AUT190 | Numerical methods in MatLab | Б | 5 | 3 | 2/1/0 | |
| | | AUT191 | Numerical Methods in Python | | | | 2/1/0 | |
| | Всего: | | | | 5 | 3 | | |
| | | | 4 semester | | | | | |
| | 2202 | CHE198 | Process automation facilities | Б | 5 | 3 | 2/0/1 | |
| | | ISO 160 | Technology of robotic production | | | | 2/1/0 | |
| | Total: | | | | 5 | 3 | | |
| | | | 5 semester | | | | | |
| 3 | 3203 | AUT407 | Database management systems | Б | 5 | 3 | 2/1/0 | |
| | | AUT106 | Information support of management systems | | | | 2/1/0 | |
| | 3204 | AUT192 | Metrology and electrical measurements (stands) | Б | 5 | 3 | 1/1/1 | |
| | | AUT193 | Electrical measuring instruments | | | | 1/1/1 | |
| | 3205 | ELC 440 | Telecommunication networks of industrial enterprises | Б | 5 | 3 | 2/0/1 | |
| | | ELC 428 | Fiber optic sensors and systems | | | | 2/1/0 | |
| | 3206 | AUT194 | Optimization methods in MatLab | Б | 3 | 2 | 1/1/0 | |
| | | AUT195 | Optimization techniques in Python | | | | 1/1/0 | |
| | Total: | | | | 18 | 11 | | |
| | | | 6 semester | | | | | |
| | 3207 | AUT196 | Neural network automation technologies | Б | 5 | 3 | 2/1/0 | |
| | | AUT197 | Neural network robotics technologies | | | | 2/1/0 | |
| | 3208 | AUT198 | Elements and devices of automation (stands) | Б | 5 | 3 | 1/1/1 | |
| | | AUT199 | Elements and devices of robotics | | | | 1/1/1 | |
| | 3209 | AUT184 | Microcontroller programming | Б | 5 | 3 | 2/1/0 | |
| | | AUT183 | Microcontroller programming for robotic systems | | | | 2/1/0 | |
| | 3210 | CSE199 | Programming on Python language | Б | 5 | 3 | 2/1/0 | |
| | | CSE127 | Object oriented programming | | | | 1/1/1 | |
| | 3301 | AUT186 | Typical controllers of automation systems | П | 3 | 2 | 1/0/1 | |
| | | AUT187 | Local control system | | | | 1/1/0 | |
| | Total: | | | | 24 | 17 | | |
| | | | 7 semester | | | | | |
| 4 | 4302 | AUT404 | Reliability of automation systems | П | 5 | 3 | 2/0/1 | |
| | | AUT405 | Reliability of technical systems | | | | 2/0/1 | |
| | 4211 | AUT409 | Actuators of Automation Systems | Б | 5 | 3 | 2/1/0 | |
| | | AUT188 | Industrial robots and manipulator drives | | | | 1/1/1 | |
| | 4303 | AUT422 | Microprocessor-based systems in the control systems | П | 5 | 3 | 2/1/0 | |
| | | AUT189 | Microcontrollers in robotization systems | | | | 2/1/0 | |
| | 4304 | AUT140 | Installation and adjustment of electrical devices of control systems | П | 5 | 3 | 1/1/1 | |
| | | AUT172 | Installation and adjustment of robotic systems | | | | 2/0/1 | |
| | 4305 | AUT400 | Fundamentals of MES - systems | П | 3 | 2 | 1/1/0 | |
| | | AUT401 | Manipulation robots control | | | | 1/1/0 | |
| | Total: | | | | 23 | 14 | | |
| | | | 8 semester | | | | | |
| | 4306 | AUT168 | Automation of typical technological processes and production | П | 5 | 3 | 1/1/1 | |
| | | AUT180 | Industrial robot control systems | | | | 2/1/0 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4307 | AUT419 | CAD Engineering Fundamentals | II | 5 | 3 | 2/0/1 | |
| | AUT173 | Design of robotization systems | | | | 2/0/1 | |
| 4308 | AUT402 | SCADA system | II | 5 | 3 | 2/1/0 | |
| | AUT167 | Robotic automation of production processes | | | | 1/1/1 | |
| Total: | | | | 15 | 9 | | |

| The number of credits in elective disciplines for the entire period of study | | |
|---|---|---|
| Cycle of disciplines | ESTS | Credits |
| Cycle of basic disciplines (B): | 53 | 32 |
| Cycle of special disciplines (S): | 36 | 22 |
| OVERALL: | 89 | 54 |

Decision of the Academic Council of the Institute of Industrial Automation and Digitalization. Minutes № 12, dated "07" 06 2021

Head of Department "Automation and Control" N.U. Aldyarov

Representative of Specialty council S.K. Abdigaliyev

| Year of study | Code | Name of discipline | Cycle | Credits | Total hours | lec/lab/pr /ISW | SRS (including SRSP), in hours | pre-requisites |
|---|---|---|---|---|---|---|---|---|
| | 1 semester (fall 2021) | | | | | | | |
| 1 | LNG108 | English | G | 5 | 150 | 0/0/3 | 105 | Dиostitest |
| | LNG104 | Kazakh (Russian) language | G | 5 | 150 | 0/0/3 | 105 | Dиostitest |
| | KFK101 | Physical education I | G | 2 | 60 | 0/0/2 | 30 | |
| | HUM100 | Modern history of Kazakhstan | G | 5 | 150 | 1/0/2 | 105 | |
| | HUM128 | Political science | G | 2 | 60 | 1/0/0 | 45 | |
| | GEN177 | Engineering and computer graphics | B | 5 | 150 | 1/0/2 | 105 | |
| | PHY111 | Physics I | B | 5 | 150 | 1/1/1 | 105 | |
| | MAT101 | Mathematics I | B | 5 | 150 | 1/0/2 | 105 | |
| | Total: | | | 34 | | | | |
| | 3 semester (fall 2022) | | | | | | | |

| Code | Name of discipline | Cycle | Credits | Total hours | lec/lab/pr /ISW | SRS (including SRSP), in hours | pre-requisites |
|---|---|---|---|---|---|---|---|
| 2 semester (spring 2022) | | | | | | | |
| LNG108 | English | G | 5 | 150 | 0/0/3 | 105 | LNG105 |
| LNG104 | Kazakh (Russian) language | G | 5 | 150 | 0/0/3 | 105 | LNG107 |
| KFK102 | Physical education II | G | 2 | 60 | 0/0/2 | 30 | KFK101 |
| HUM129 | Culturology | G | 2 | 60 | 1/0/0 | 45 | |
| MAT102 | Mathematics II | B | 5 | 150 | 1/0/2 | 105 | MAT101 |
| PHY112 | Physics II | B | 5 | 150 | 1/1/1 | 105 | PHY111 |
| CHE495 | Chemistry | B | 5 | 150 | 1/1/1 | 105 | |
| | | | | | | | |
| Total: | | | 29 | | | | |
| 4 semester (spring 2023) | | | | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CHE452 | Ecology and sustainable development | G | 2 | 60 | 1/0/0 | 45 | | MNG487 | Fundamentals of Entrepreneurship, Leadership and Anti-corruption culture | G | 3 | 90 | 1/0/1 | 60 | |
| | HUM127 | Sociology | G | 2 | 60 | 1/0/0 | 45 | | HUM122 | Psychology | G | 2 | 60 | 1/0/0 | 45 | |
| | CSE677 | Information and Communication technology | G | 5 | 150 | 2/1/0 | 105 | | HUM132 | Philosophy | G | 5 | 150 | 1/0/2 | 105 | |
| | KFK103 | Physical education III | G | 2 | 60 | 0/0/2 | 30 | KF102 | CHE451 | Life safety | G | 2 | 60 | 1/0/0 | 45 | |
| | MAT103 | Mathematics III | B | 5 | 150 | 1/0/2 | 105 | M[illegible]102 | KFK104 | Physical education IV | G | 2 | 60 | 0/0/2 | 30 | AAP122 |
| | ELC541 | Theoretical Foundations of Electrical Engineering | B | 5 | 150 | 2/1/0 | 90 | | AUT413 | Mathematical Foundations of control theory | Б | 5 | 150 | 2/0/1 | 105 | |
| | AUT423 | Computer modeling and programming in MatLab | B | 5 | 150 | 1/2/0 | 105 | | ROB502 | Basics of Electronics | B | 5 | 150 | 1/1/1 | 90 | |
| | 2201 | Elective | B | 5 | 150 | | 105 | | 2202 | Elective | B | 5 | 150 | | 105 | |
| | Total: | | | 31 | | | | | Total: | | | 29 | | | | |
| 3 | 5 semester (fall 2023) | | | | | | | | 6 semester (spring 2024) | | | | | | | |
| | 3203 | Elective | B | 5 | 150 | | 105 | | 3207 | Elective | B | 5 | 150 | | 105 | |
| | 3204 | Elective | B | 5 | 150 | | 105 | | 3208 | Elective | B | 5 | 150 | | 105 | |
| | 3205 | Elective | B | 5 | 150 | | 105 | | 3209 | Elective | B | 5 | 150 | | 105 | |
| | 3206 | Elective | B | 3 | 150 | | 105 | | 3210 | Elective | B | 5 | 150 | | 105 | |
| | ROB50 | Integral and microprocessor circuit design | S | 5 | 150 | 2/1/0 | 105 | | AUT4 | Nonlinear [illegible]tem of the [illegible]omatic [illegible]ntrol | S | 5 | 150 | 1/1/1 | 105 | |
| | AUT41 | Linear [illegible]tem of [illegible]tomatic [illegible]ntrol | S | 5 | 150 | 1/1/1 | 90 | | 3301 | Elective | S | 3 | 90 | | 60 | |
| | Total: | | | 28 | | | | | Total: | | | 28 | | | | |
| 4 | 7 semester (fall 2024) | | | | | | | | 8 semester (spring 2025) | | | | | | | |
| | 4211 | Elective | B | 5 | 150 | | 105 | | 4306 | Elective | S | 5 | 150 | | 105 | |
| | AUT40 | Intelligent [illegible]cess control [illegible]tems | S | 5 | 150 | 1/2/0 | 105 | | 4307 | Elective | S | 5 | 150 | | 105 | |
| | 4302 | Elective | S | 5 | 150 | | 105 | | 4308 | Elective | S | 5 | 150 | | 105 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 4303 | Elective | S | 5 | 150 | | 105 | |
| | 4304 | Elective | S | 5 | 150 | | 105 | |
| | 4305 | Elective | S | 3 | 90 | | 60 | |
| | Total: | | | 28 | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ECA003 | Preparation and writing the thesis (project) | FA | 6 | | | | | |
| ECA103 | Graduate sis (project) ense | FA | 6 | | | | | |
| Total: | | | 27 | | | | | |

| Year of | Code | Name of discipline | Cle | Credits | Semester |
|---|---|---|---|---|---|
| Obligatory education with P/NP assessment | | | | | |
| 1 | AAP101 | Educational Internship (B) | B | 2 | 2 |
| 2 | AAP174 | Industrial internship I (S) | S | 2 | 4 |
| 3 | AAP175 | Industrial internship II (S) | S | 4 | 6 |
| Other education | | | | | |
| 1 | AAP107 | Physical ication III, IV | G | 0 | 3-7 |
| 2 | AAP500 | Military ining | G | 0 | 3-6 |

| Total number of credits | | | | |
|---|---|---|---|---|
| Cycle of disciplines | Credits | | | |
| | compul-sary | elective | practice | total |
| Cycle of general ciplines (G) | 51 | 7 | 0 | 58 |
| Cycle of basic ciplines (B) | 55 | 53 | 4 | 112 |
| Cycle of special ciplines (S) | 20 | 36 | 4 | 60 |
| Total of theoretical study : | 126 | 96 | 8 | 230 |
| Final attestation A) | 12 | 0 | 12 | 12 |
| OVERALL: | 138 | 96 | 20 | 242 |

MAJOR ELECTIVE DISCIPLINES

| Year of study | Curriculum elective code | Discipline Code | Name of disciplines | Cycle | ESTS | Credits | lec/lab/pr | pre-requisites |
|---|---|---|---|---|---|---|---|---|
| 2 | 3 semester | | | | | | | |
| | 2201 | AUT190 | Numerical methods in MatLab | Б | 5 | 3 | 2/1/0 | |
| | | AUT191 | Numerical Methods in Python | | | | 2/1/0 | |
| | Всего: | | | | 5 | 3 | | |
| | 4 semester | | | | | | | |
| | 2202 | CHE198 | Process automation facilities | Б | 5 | 3 | 2/0/1 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | ISO 160 | Technology of robotic production | | | | 2/1/0 | |
| | Total: | | | | 5 | 3 | | |
| 3 | 5 semester | | | | | | | |
| | 3203 | AUT407 | Database management systems | Б | 5 | 3 | 2/1/0 | |
| | | AUT106 | Information support of management systems | | | | 2/1/0 | |
| | 3204 | AUT192 | Metrology and electrical measurements (stands) | Б | 5 | 3 | 1/1/1 | |
| | | AUT193 | Electrical measuring instruments | | | | 1/1/1 | |
| | 3205 | ELC440 | Telecommunication networks of industrial enterprises | Б | 5 | 3 | 2/0/1 | |
| | | ELC428 | Fiber optic sensors and systems | | | | 2/1/0 | |
| | 3206 | AUT194 | Optimization methods in MatLab | Б | 3 | 2 | 1/1/0 | |
| | | AUT195 | Optimization techniques in Python | | | | 1/1/0 | |
| | Total: | | | | 18 | 11 | | |
| | 6 semester | | | | | | | |
| | 3207 | AUT196 | Neural network automation technologies | Б | 5 | 3 | 2/1/0 | |
| | | AUT197 | Neural network robotics technologies | | | | 2/1/0 | |
| | 3208 | AUT198 | Elements and devices of automation (stands) | Б | 5 | 3 | 1/1/1 | |
| | | AUT199 | Elements and devices of robotics | | | | 1/1/1 | |
| | 3209 | AUT184 | Microcontroller programming | Б | 5 | 3 | 2/1/0 | |
| | | AUT183 | Microcontroller programming for robotic systems | | | | 2/1/0 | |
| | 3210 | CSE199 | Programming on Python language | Б | 5 | 3 | 2/1/0 | |
| | | CSE127 | Object oriented programming | | | | 1/1/1 | |
| | 3301 | AUT186 | Typical controllers of automation systems | П | 3 | 2 | 1/0/1 | |
| | | AUT187 | Local control system | | | | 1/1/0 | |
| | Total: | | | | 28 | 17 | | |
| 4 | 7 semester | | | | | | | |
| | 4302 | AUT404 | Reliability of automation systems | П | 5 | 3 | 2/0/1 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | AUT405 | Reliability of technical systems | | | | 2/0/1 | |
| 4211 | AUT409 | Actuators of Automation Systems | Б | 5 | 3 | 2/1/0 | |
| | AUT188 | Industrial robots and manipulator drives | | | | 1/1/1 | |
| 4303 | AUT422 | Microprocessor-based systems in the control systems | П | 5 | 3 | 2/1/0 | |
| | AUT189 | Microcontrollers in robotization systems | | | | 2/1/0 | |
| 4304 | AUT140 | Installation and adjustment of electrical devices of control systems | П | 5 | 3 | 1/1/1 | |
| | AUT172 | Installation and adjustment of robotic systems | | | | 2/0/1 | |
| 4305 | AUT400 | Fundamentals of MES - systems | П | 3 | 2 | 1/1/0 | |
| | AUT401 | Manipulation robots control | | | | 1/1/0 | |
| Total: | | | | 23 | 14 | | |
| 8 semester | | | | | | | |
| 4306 | AUT168 | Automation of typical technological processes and production | П | 5 | 3 | 1/1/1 | |
| | AUT180 | Industrial robot control systems | | | | 2/1/0 | |
| 4307 | AUT419 | CAD Engineering Fundamentals | П | 5 | 3 | 2/0/1 | |
| | AUT173 | Design of robotization systems | | | | 2/0/1 | |
| 4308 | AUT402 | SCADA-system | П | 5 | 3 | 2/1/0 | |
| | AUT167 | Robotic automation of production processes | | | | 1/1/1 | |
| Total: | | | | 15 | 9 | | |

| The number of credits in elective disciplines for the entire period of study | | |
|---|---|---|
| Cycle of disciplines | ESTS | Credits |
| Cycle of basic disciplines (B) | 53 | 32 |
| Cycle of special disciplines (S) | 36 | 22 |
| OVERALL: | 89 | 54 |

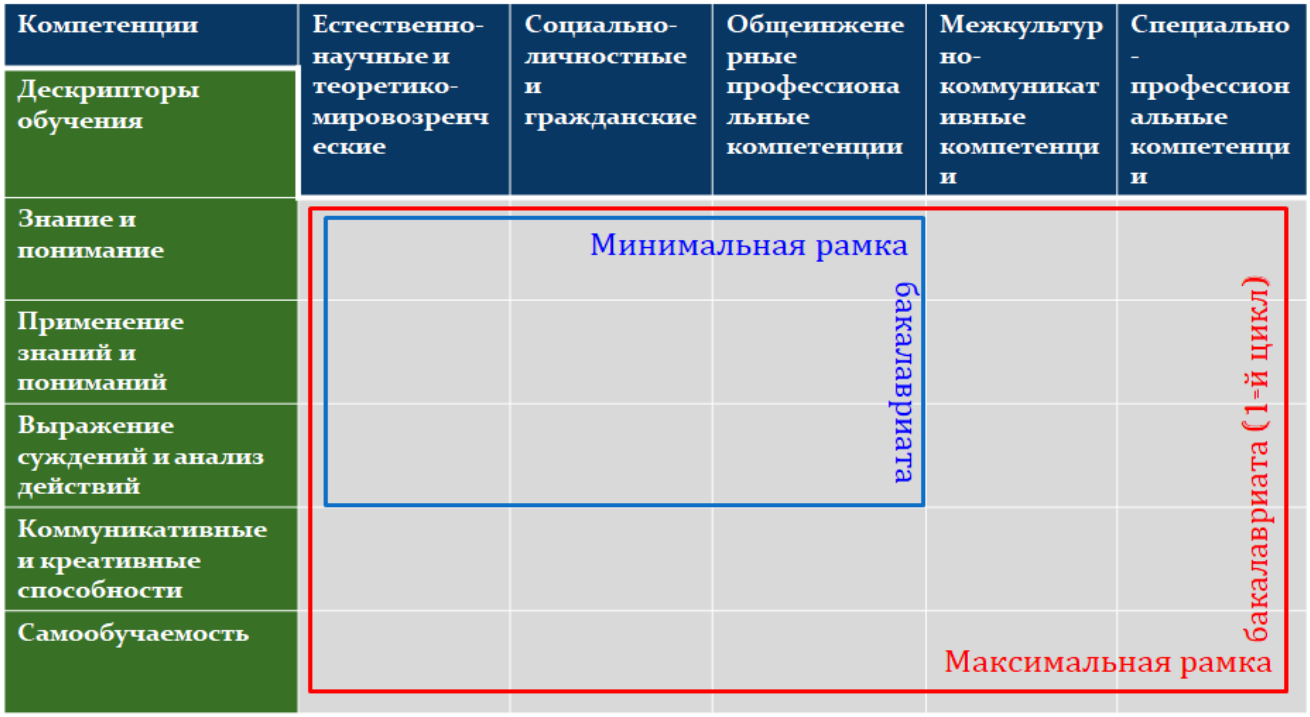
## 5 Descriptors of the level and volume of knowledge, skills and competencies

A - knowledge and understanding that demonstrate them, formed on the basis of secondary education, including certain advanced knowledge in the field of automation and robotics:
A1 - synthesis methods of management systems and automated digital control systems for technological processes and industries;
A2 - methods of constructing functional circuits for the design of automated process control systems and robotic systems in various industries;
A3 - modern trends in the development of technical support for automation systems and robotization of production processes;
A4 - standards, methodological and regulatory materials that accompany the operation, installation and commissioning of automated control systems and robotic technological complexes in various industries.
B - the application of knowledge and understanding that attests to a professional approach through acquisition of a number of competencies:
B1 — independent work and offering various options for solving professional problems using theoretical and practical knowledge
B2 –for the organization of work on the operation, installation and commissioning of technical means of automation systems and robotization of production processes;
B3 –for the organization of work on the collection, storage and processing of information used in the area of professional activity.
C - expression of judgment and analysis of actions by accumulating, evaluating, processing and interpreting data, knowledge:
C1 — about modern automated process control systems and robotic technological complexes;
C2– about modern approaches of using software for comparative analysis and evaluation of automation systems and robotization of production processes, including applying of artificial intelligence methods;
C3 — about the modern technical support for automation and robotization systems with technical means (sensors, actuators, microcontrollers, specialized microprocessors, etc.) which are used in the automation and robotization of production processes;
D - communication skills and IT skills by interpretation real and virtual information, problems and their solutions, ideas and their implementation to both specialists and non-specialists in the field of automation, artificial intelligence robotization and digitalization of production.
E - self-learning and existential skills by developing skills of seif-study training and retraining with a high degree of self-dependence, in the field of automation and robotics areas.

## 6 Completion Competencies

### 6.1 Minimum competency framework for SU graduate

At the university, on the basis of training descriptors and basic framework competencies, the following framework characterization of graduate competencies is adopted, which guarantees the achievement of a competitive level in the professional market.




Based on this competency framework, competencies, subcompetencies, learning outcomes and the competency matrix of the EP "Automation and Robotization" are formed.

### 6.2 The maximum competency framework of a graduate of the EP "Automation and Robotization"

**Learning outcomes at the EP "Automation and Robotization"**

| | |
|---|---|
| $PO_1$ | Own state, Russian and one of the most common foreign languages and use them in their professional activities. To be ready for intellectual, cultural, physical and spiritual self-perfection to enhance their qualifications throughout their work. |
| $PO_2$ | To possess the basics of knowledge of legal and ethical standards, as well as linguistic, social and economic knowledge, methods and methods of organizing production and complying with safety, health and environmental regulations. |

| | |
|---|---|
| $PO_3$ | Demonstrate knowledge of the sections of higher mathematics, physics, electronics, electrical engineering and other natural sciences and apply them to solve engineering problems in the field of automation and control |
| $PO_4$ | To possess modern computer, information, communication technologies and software used in the creation and operation of automation systems. |
| $PO_5$ | Make a selection of measuring instruments and automation equipment, measure technological parameters, set up and operate automation components and devices. |
| $PO_6$ | Possess programming skills in high-level languages, microcontroller programming tools and languages, modeling software and research of automated process control systems. |
| $PO_7$ | To put into practice knowledge on the main types of linear and non-linear automatic control systems, their mathematical description and modeling. Perform calculations for the analysis and synthesis of regulatory systems. |
| $PO_8$ | To possess methods of information processing and synthesis of automation systems, methods of designing and programming data management systems. To use in practice the functionality of Scada-systems. |
| $PO_9$ | Develop structural, functional and other automation schemes, analyze reference and regulatory literature, draw up technical documentation. Develop technical, software, mathematical, algorithmic, informational and other. supply of automated process control systems |
| $PO_{10}$ | Use the technical capabilities of microprocessor technology, means of reception and transmission of information and software products to solve automation problems. |
| $PO_{11}$ | Analyze and evaluate the state of automation objects, technological processes and production. Make qualified decisions on the use of elements and automation systems, their installation, commissioning and operation. |
| $PO_{12}$ | To possess the knowledge and skills to implement a systems approach to the development and implementation of automation systems and robotization of production processes. |

## Matrix of correlation of the learning outcomes of the educational program with the formed competencies

| **Core Competencies / Learning Outcomes** | **$PO_1$** | **$PO_2$** | **$PO_3$** | **$PO_4$** | **$PO_5$** | **$PO_6$** | **$PO_7$** | **$PO_8$** | **$PO_9$** | **$PO_{10}$** | **$PO_{11}$** | **$PO_{12}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Professionalcompetencies | | | | | V | V | V | V | V | V | V | V |
| Research competencies | | | | | | | | | | V | V | V |
| Basic competencies and knowledge | | | V | V | | | | | | | | |
| Communicative competencies | V | V | | V | | | | | | | | |
| Human competences | V | V | | V | | | | | | | | |
| Managerial competencies | V | V | | V | | | | | | | | V |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cognitive competencies | | | V | V | | | | | | | | |
| Creative competencies | V | | V | V | | | | | | | | |
| Information and Communication Competencies | | | | V | | V | | V | | V | | |

**6.3 Competency framework of compulsory major disciplines of the EP "Automation and Robotization"**

Mandatory specialized disciplines of the EP "Automation and Robotization", approved by the Ministry of Education and Science of the Republic of Kazakhstan, are: "Linear systems of automatic adjustment", "Nonlinear systems of automatic adjustment" and "Theoretical foundations of electrical engineering". The matrices for correlation of learning outcomes in these disciplines with subcompetencies are shown below.

**Subcompetencies obtained by graduates of the EP "Automation and Robotization"**

Graduates of the EP "Automation and Robotization" must ensure the implementation of the state program "Digital Kazakhstan", aimed at achieving the goals of the Kazakhstan economy strategy Industry 4.0 in all areas of industry and electric power, mining and metallurgy, agriculture, construction ("smart city" and " smart home "), as well as the digitalization of the activities of public authorities, which affects almost all sectors of our lives - from medical services and education, to industrial production and business in general. Consequently, EP "Automation and Robotization" allows to achieve the following subcompetencies.

Б – Basic knowledge, skills:

$Б_1$ – to be capable of philosophical analysis of social phenomena, personality behavior and other phenomena. Ready to conduct a philosophical assessment of social phenomena;

$Б_2$ – to know and put into practice the basics of engineering professional ethics;

$Б_3$ – to be able to analyze current problems of the modern history of Kazakhstan.

П – Professional competencies:

$П_1$ – a wide range of theoretical and practical knowledge in the professional field;

$П_2$ – able to analyze and solve problems in the theory of electric circuits of direct and alternating currents;

$П_3$ – able to analyze electrical and wiring diagrams of industrial automation and robotic industries. Ready to make assembling and setting up and operation of automation systems and robotic systems.

$П_4$ – ready to participate in the digitalization of production along the entire control chain: sensors → regulation system → automated control system → site → workshop → enterprise.

О - Human, socio-ethical competencies:

$O_1$- to be able to freely use the English language as a means of business communication, a source of new knowledge in the field of automation or robotization of production processes. Ready to use English in professional activities in the field of automation and control;
$O_2$ - to be able to fluently speak the Kazakh (Russian) language as a means of business communication, a source of new knowledge in the field of automation or robotization of production processes. Ready to use the Kazakh (Russian) language in professional activities in the field of automation and control;
$O_3$ - to know and apply in work and life the basics of applied ethics and business communication ethics;
$O_4$ - to know and apply the basic concepts of professional ethics;
$O_5$ - to know and put into practice the "code of ethics of an engineer";
$O_6$ - to know and solve the problems of human influence on the environment.
C - Special and managerial competencies:
$C_1$ - independent management and control of the processes of labor and educational activities within the framework of the strategy, policy and goals of the organization, discussion of the problem, argumentation of conclusions and competent handling of information;
$C_2$ - *in the area of organizational and managerial activities*: to be the leader of a group of the unit for operation, maintenance, service, repair of elements, devices of automated control systems and robotic technological complexes in various industries;
$C_3$ - *in the area of experimental research*: to be a specialist in conducting experimental studies of objects of automation and robotization of industrial production;
$C_4$ - *in the research area*: to be an engineer in a scientific laboratory for the research and development of modern automated control systems and robotic technological complexes in various industries;
$C_5$ - *in the field of design activity*: to be an engineer of the development and design of automated control systems and robotic technological complexes in various industries.

**Development of a matrix for correlating learning outcomes of the core discipline “Linear automatic control systems” (LACS) with subcompetencies**

**LACS** Discipline Learning Outcomes
$PO_{11}$ - principles and schemes of automatic control;
$PO_{12}$- mathematical description of control systems in the time, complex and frequency domains;
$PO_{13}$ - construction of time and frequency characteristics of automatic control systems;
$PO_{14}$ - methods for studying the stability of linear systems of automatic regulation and control;
$PO_{15}$- methods for assessing the quality of the regulatory process.

| **Subcompetencies / LACS** Discipline Learning Outcomes | **PO11** | **PO12** | **PO13** | **PO14** | **PO15** |
|---|---|---|---|---|---|
| Б – Basic knowledge, skills | V | V | | | |
| $П_1$ – a wide range of theoretical and practical knowledge in the professional field | V | V | V | V | V |
| $П_2$ –to be able to analyze and solve problems in the theory of electric circuits of direct and alternating currents | V | V | V | V | V |
| $П_3$ – to be able to analyze electrical and wiring diagrams of industrial automation and robotic industries. Ready to make assembling and setting up, operation of automation systems and robotic systems | V | | | | |
| $П_4$ – ready to participate in the digitalization of production along the entire control chain: sensors → regulation system → automated control system → site → workshop → enterprise. | V | V | V | V | V |
| О – Human, socio-ethical competencies | V | | | | |
| С – Special and managerial competencies | V | | | | |

**Development of a matrix for correlating learning outcomes of the core discipline "Non-linear automatic control systems" (NLACS) with subcompetencies**

**NLACS** Discipline Learning Outcomes:

$PO_{21}$ - study of the essential features of nonlinear systems;

$PO_{22}$- mathematical models in state space;

$PO_{23}$ - accurate and approximate methods for analyzing the stability of nonlinear systems — phase plane method, second Lyapunov method, harmonic linearization, Goldfarb criterion, criteria for determining self-oscillations (Mikhailova, Gurvitsa);

$PO_{24}$ - basic terms of impulse systems, mathematical models of impulse systems; research of stability and quality of impulse systems.

| **Subcompetencies / NLACS** Discipline Learning Outcomes | **PO21** | **PO22** | **PO23** | **PO24** |
|---|---|---|---|---|
| Б – Basic knowledge, skills | V | V | | |
| $П_1$ – a wide range of theoretical and practical knowledge in the professional field | V | V | V | V |
| $П_2$ –to be able to analyze and solve problems in the theory of electric circuits of direct and alternating currents | V | V | V | V |
| $П_3$ – to be able to analyze electrical and wiring diagrams of industrial automation and robotic industries. Ready to make assembling and setting up, operation of automation systems and robotic systems | V | | | |
| $П_4$ – ready to participate in the digitalization of production along the entire control chain: sensors → regulation system → automated control system → site → workshop → enterprise. | V | V | V | V |

| | | | | | |
|---|---|---|---|---|---|
| О – Human, socio-ethical competencies | V | | | | |
| С – Special and managerial competencies | V | | | | |

**Development of a matrix for correlating learning outcomes of the core discipline "Theoretical bases of electrical engineering" (TBEE) with subcompetencies.**

Discipline Learning Outcomes **TBEE** :

$PO_{31}$ -basic terms and definitions used in electrical engineering;
$PO_{32}$- modern methods of modeling electromagnetic processes;
$PO_{33}$ – modern analytics ofelectrical and magnetic circuits;
$PO_{34}$ - numerical methods for the analysis of electrical circuits;
basic laws and principles of electrical engineering, properties and characteristics of electrical circuits;
$PO_{35}$ - analytics of electrical circuits in steady and transient modes;
$PO_{36}$-the choice of the optimal calculation method, to determine the main parameters and characteristics of electrical circuits выбор

| **Subcompetencies / TBEE** Discipline Learning Outcomes | **$PO_{31}$** | **$PO_{32}$** | **$PO_{33}$** | **$PO_{34}$** | **$PO_{35}$** | **$PO_{36}$** |
|---|---|---|---|---|---|---|
| Б – Basic knowledge, skills | V | V | | | | |
| $П_1$ – a wide range of theoretical and practical knowledge in the professional field | V | V | V | V | | |
| $П_2$ – to be able to analyze and solve problems in the theory of electric circuits of direct and alternating currents | V | V | V | V | V | V |
| $П_3$ – to be able to analyze electrical and wiring diagrams of industrial automation and robotic manufactoring. Ready to make assembling and setting up, operation of automation systems and robotic systems | | | V | V | V | V |
| О – Human, socio-ethical competencies | V | | | | | |
| С – Special and managerial competencies | V | | | | | V |

**Matrix of competencies of the educational program "Automation and Robotization"**

| Discipline Index | Name of the discipline | Generalcultural | | | | | | | | | General professional | | | | | Professional | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GC-1 | GC -2 | GC -3 | GC -4 | GC -5 | GC -6 | GC -7 | GC -8 | GC -9 | GPC -1 | GPC -2 | GPC -3 | GPC -4 | GPC -5 | PC -1 | PC -2 | PC -3 | PC -4 | PC -5 | PC -6 | PC -7 | PC -8 | PC -9 | PC -10 |
| **Required component** | | | | | | | | | | | | | | | | | | | | | | | | | |
| LNG105 | English | x | | | | | x | | x | | x | | | | | | | | | | | | | | |
| LNG101 | Kazakh (Russian) language | x | | | | | x | | x | | | | | | | | | | | | | | | | |
| MAT110 | Algebra and beginning of mathematical analysis | | | | | | | | | | | | x | x | x | | | | | | | | | | |
| MAT101 | Mathematics I | | | | | | | | | | | | | | | | x | | x | | x | x | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAT102 | Mathematics II | | | | | | | | | | | | | | x | | x | | x | x | | | |
| MAT103 | Mathematics III | | | | | | | | | | | | | | x | | x | | x | x | | | |
| HUM113 | Modern history of Kazakhstan | | | x | | | | | | | | | | | | | | | | | | | |
| PHY110 | Beginnings of physics | | | | | | | | | | | | | | | | | | | | | | |
| PHY111 | Physics I | | | | | | | | | | | | | | | | | | | | | | |
| PHY112 | Physics II | | | | | | | | | | | | | | | | | | | | | | |
| AUT163 | Introduction to the specialty Engineering ethics | | | | | | | | | | | x | x | | x | | x | | x | | | | |
| GEN101 | Engineering and computer graphics | | | | | | | | | | | | | x | | x | | | | | x | x | |
| HUM124 | Philosophy | | x | | x | x | | x | x | | | | | | | | | | | | | | |
| MAT126 | Ordinary Differentiation Equations MatLab | | | | | | | | | | | | | | x | | x | | x | x | | | |
| MAT127 | Partial Differentiation Equations MatLab | | | | | | | | | | | | | | x | | x | | x | x | | | |
| ELC163 | Theoretical foundations of electrical engineering (IKT) | | | | | | | | | | | | | x | | x | | | | | | x | |
| CHE198 | Technological automation obje cts | | x | | | | x | x | x | | x | | | | | | | | | | | | |
| HUM126 | Social &Political knowledge | | | | | | | | | | | | | | | x | | | | x | | | x |
| ISO 160 | Robotic Production Technology | | | | | | | | | | | | x | | x | | | x | | | | | |
| AUT102 | Databases in control systems | | | | | | | | | | | | x | | x | | | x | | | | | |
| AUT139 | Strength of materials | | | | | | | | | | | | x | | | | | x | | | x | | x |
| AUT164 | Computer modeling and programming in MatLab | | | | | | | | | | | | x | | | | | | x | | | | |
| AUT115 | Mathematical foundations of control theory | | | | | | | | | | | | | x | | x | | x | | | | | |
| AUT159 | Electronic automation devices | | | | | | | | | | | | | | | | | | x | x | | | |
| AUT119 | Optimization methods (with ele ments AI) | | | | | | | | | | | | | | x | | | | x | x | | | |
| ELC162 | Microelectronics | | | | | | | | | | | | | | | | | x | | | | x | |
| AUT111 | Linear automatic control systems | | | | | | | | | | | | | | | | | | | x | | | |
| AUT108 | Executive devices of automation systems | | | | | | | | | | | | | | | | x | | | | | x | |
| AUT154 | Microprocessor-based systems in the control systems | | | | | | | | | | | | | x | x | | | | x | | | | |
| AUT128 | Foundations of Industrial Robotics | | | | | | | | | | x | | | | | | | | | | x | | x |
| AUT124 | Nonlinear automatic control systems | | | | | | | | | | | | | | | | | | | x | | | |
| AUT112 | Local control system | | | | | | | | | | | | | | | | | | | x | | | |
| AUT167 | Robotization of production processes | | | | | | | | | | | x | | | | | | | | | x | | |
| AUT116 | Mathematical modeling of automation objects (with elements AI) | | | | | | | | | | | | | | x | | | | x | | | | |
| AUT166 | Designing of automation and robotization systems | | | | | | | | | | | | | | | x | | | | | | x | |
| | **Elective courses** | | | | | | | | | | | | | | | | | | | | | | |
| CSE199 | Python programming | | | | | | | | | | | | | | x | | | | x | | | | |
| CSE127 | Object oriented programming | | | | | | | | | | | | | | x | | | | x | | | | |
| AUT101 | Automation of typical technological processes and production | | | | | | | | | | | | | x | | | | | | | x | | x |
| AUT125 | Operational Production Management | | | | | | | | | | x | x | x | x | | | | | | | | | |
| AUT122 | Installation and adjustment of automation systems | | | | | | | | | | | | | | | | | x | | | | x | |
| AUT123 | Installation and adjustment of electro technical devices | | | | | | | | | | | | | | | | | x | | | | x | |
| AUT104 | Installation and commissioning of automation systems | | | | | | | | | | | | | | x | | | | | | | | x |
| AUT165 | Installation and commissioning of electrical devices | | | | | | | | | | | | | | x | | | | | | | | x |

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| **State final certification** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ECA101 | Graduate thesis (project) preparation | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| ECA102 | The defence of graduation work (project) | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Additional types of training** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AAP106 | Physical education I | | x | | | | | | x | | | | | | | | | | | | | | | | | |
| AAP101 | Training Practice | | | | | | | | | | | | | | | | | | | x | | | | x | | |
| AAP109 | Industrial internship I | | | | | | | | | | | | | | | | | | | x | | | | x | | |
| AAP103 | Industrial internship II | | | | | | | | | | | | x | x | x | | | | | | | | | x | | |

## 7 Further education policy Minor

Mastering at least 12 credits by the program disciplines, including compulsory disciplines
M1- English language;
M2 - Modern history of Kazakhstan;
M3 - Physics 1 and 2;
M4 - Mathematics 1,2,3;
M5- Theoretical foundations of electrical engineering;
M6 - Linear automatic control systems;
M7- Nonlinear automatic control systems.
the graduate is assigned an additional Minor specialty with the issuance of an application to the diploma of the established sample.

## 8 Annex to the diploma for ECTS and the MES RKstandard

Certificate, 3071364, June 05, 2012.

Kazakh National Technical University named after K.I. Satpayev, 2012.

Kazakh National Research Technical University named after K.I. Satpayev, 2017.

NAC MES RK (www.nac.edu.kz), EAU (www.eua.be), ASIIN (Germany, www.asiin.de)

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3.10

| | | | | | | |
|---|---|---|---|---|---|---|
| RK | ECTS | | | | | |
| Educational practice | | 4 | 2 | A- | 3.67 | 5 |
| Production practice | | 3 | 8 | A | 4 | 5 |
| Production practice | | 3 | 8 | B- | 2.67 | 4 |
| Pre-diploma practice | | 5 | 13 | B- | 2.67 | 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| RK | ECTS | | | | | |
| History of Kazakhstan | | 3 | 5 | A- | 3.67 | 5 |
| MCC on the specialty | | 1 | 4 | B | 3 | 4 |

Diploma work (project)

| | | | | | | |
|---|---|---|---|---|---|---|
| RK | ECTS | | | | | |
| Automatic control systemof a steam boilerДЕ-10-14 ГМ | | 2 | 7 | B- | 2.67 | 4 |

***Kazakh National Research Technical University named after K.I. Satpayev***

| | | | РК | ECTS | | | |
|---|---|---|---|---|---|---|---|
| 1 | Fil 1111 | Philosophy | 3 | 5 | A- | 3.67 | 5 |
| 2 | OET 1107 | Foundations of economic theory | 2 | 3 | A- | 3.67 | 5 |
| 3 | IYa 2108 | Foreign language | 6 | 10 | B+ | 3.33 | 4 |
| 4 | K(R)Ya 1106 | Kazakh (Russian) language | 6 | 10 | A- | 3.67 | 5 |
| 5 | FK | Physical education | 8 | | C+ | 2.33 | 3 |
| 6 | Inf 1102 | Computer science | 3 | 5 | A- | 3.67 | 5 |
| 7 | Him 2210 | Chemistry | 3 | 5 | B- | 2.67 | 4 |
| 8 | Pol 1110 | Political science | 2 | 3 | A | 4 | 5 |
| 9 | OP 1109 | Law foundations | 2 | 3 | B | 3 | 4 |
| 10 | EiU 4220 | Organization and control of the production | 3 | 5 | B- | 2.67 | 4 |
| 11 | OT 4221 | Safety and Health | 3 | 5 | A- | 3.67 | 5 |
| 12 | OBJ 1103 | The basics of life safety | 2 | 3 | A | 4 | 5 |
| 13 | VP | Military training | 10 | | B- | 2.67 | 4 |
| 4 | MI 3219 | Metrology and Measurements | 3 | 5 | C | 2 | 3 |
| 15 | MOTS 228 | Mathematical foundations of the systems theory | 3 | 5 | B+ | 3.33 | 4 |
| 16 | EUA 231 | Elements and devices of automation | 3 | 5 | B | 3 | 4 |
| 17 | PM 2213 | Applied mechanics | 3 | 5 | C+ | 2.33 | 3 |
| 18 | TSA 337 | Technical means of automation | 3 | 5 | B+ | 3.33 | 4 |
| 19 | PSA 4308 | Automation systems designing | 3 | 5 | C+ | 2.33 | 3 |
| 20 | ATTP 3218 | Automation of typical tech. processes and production | 4 | 6 | B | 3 | 4 |
| 21 | Ele 3215 | Electronics | 6 | 10 | A- | 3.67 | 5 |
| 22 | MO 2213 | Optimization methods | 2 | 4 | B+ | 3.33 | 4 |
| 23 | VM(I) 1201 | Higher Mathematics I | 3 | 5 | A | 4 | 5 |
| 24 | DGYa2114 | Office work in state language | 1 | 2 | A | 4 | 5 |
| 25 | Soc 1104 | Sociology | 2 | 3 | A | 4 | 5 |
| 26 | NGKG 1201 | Descriptive geometry and computer graphics | 3 | 5 | B- | 2.67 | 4 |
| 27 | Fiz(II) 2204 | Physics II | 3 | 5 | B | 3 | 4 |
| 28 | Mat(III) 227 | Mathematics III | 4 | 6 | B | 3 | 4 |
| 29 | AiP 229.1 | Algorithmization and programming | 3 | 5 | B+ | 3.33 | 4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 30 | MKSU 336 | Microprocessor complexes in the control systems | 3 | 5 | C+ | 2.33 | 3 |
| 31 | Fiz(I) 1203 | Physics I | 3 | 5 | C+ | 2.33 | 3 |
| 32 | TOE 2205 | Theoretical foundations of electrical engineering | 4 | 6 | B- | 2.67 | 4 |
| 33 | EUR 1105 | Ecology and sustainable development | 2 | 3 | A- | 3.67 | 5 |
| 34 | PSMS 2212 | Software means of systems modeling (Matlab) | 3 | 5 | B- | 2.67 | 4 |
| 35 | TSM 4309 | Technical means and methods of information protection | 3 | 5 | C | 2 | 3 |
| 36 | MIIS 333 | Methods of artificial intelligence in control systems | 3 | 5 | A- | 3.67 | 5 |
| 37 | MMOA 334 | Mathematical modeling of automation objects | 6 | 10 | A- | 3.67 | 5 |
| 38 | ATS 4310 | Automation and control in technical systems | 4 | 7 | C | 2 | 3 |
| 39 | Fiz(III) 2211 | Physics III | 3 | 5 | C+ | 2.33 | 3 |
| 40 | VM(II) 1202 | Higher Mathematics II | 3 | 5 | A- | 3.67 | 5 |
| 41 | PK(R)Ya 3206 | Professional Kazakh Russian language | 2 | 3 | C- | 1.67 | 3 |
| 42 | P-oIYa 3207 | Professionally-oriented foreign language | 2 | 3 | B- | 2.67 | 4 |
| 43 | LSAR 3301 | Linear automation control systems | 3 | 5 | B- | 2.67 | 4 |
| 44 | NSAR 3302 | Nonlinear automation control systems | 3 | 5 | B- | 2.67 | 4 |
| 45 | PUPro 3216 | Unity Pro Programming | 6 | 10 | A | 4 | 5 |

Bachelor of Engineering and Technology
5B070200 - Automation and robotization

## 9Disciplines description

# Mathematics I

CODE - MAT101
CREDIT - 5 (1/0/2)
PREREQUISITES - Elementary school mathematics course / diagnostic test

PURPOSE AND TASKS OF THE COURSE
The main purpose of the course is to provide the future specialist with certain knowledge in the sections of the course "Mathematics-I" required for the study of engineering disciplines. To acquaint students with the ideas and concepts of mathematical analysis. Emphasis is placed on the formation of basic knowledge and skills with a high level of understanding of differential and integral calculus.
Objectives of the course: to acquire the necessary knowledge for the effective use of rapidly evolving mathematical methods; acquisition of skills of creation and research of mathematical models; mastering the basic sections of mathematics necessary for solving research and practical problems in the professional field.

BRIEF DESCRIPTION OF THE COURSE
The course "Mathematics-I" contains the following sections: introduction to analysis, differential and integral calculus.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Studying this discipline allows the student to apply the course "Mathematics-I" to solve simple practical problems, to find sufficient tools for their study and to obtain numerical results in some standard cases.

**Mathematics II**
CODE - MAT102
CREDIT - 5 (1/0/2)

PREREQUISITES - Mathematics 1

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the course "Mathematics II" is to form in bachelors ideas about modern mathematics as a logically harmonious system of theoretical knowledge.
The objectives of the course are to develop students' strong skills in solving mathematical problems, to bring the solution to a practical result. Development of basic skills of mathematical research of applied questions and the ability of the student to independently understand the mathematical apparatus in the literature, depending on the specialty.

BRIEF DESCRIPTION OF THE COURSE
In the course "Mathematics-II" there is an available presentation of sections: elements of linear algebra and analytical geometry, differential calculus of functions of many variables, several integrals. "Mathematics II" is a logical continuation of the course "Mathematics I".

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
To apply the theoretical knowledge and skills acquired in the study of this discipline in practice, with a high level of understanding of them in the sections of the course, to use them at the appropriate level; to translate simple problems in terms of other subject areas into mathematical language; to acquire new mathematical knowledge using educational and information technologies; allows you to solve applied problems in the field of professional activity.

**Mathematics III**
CODE - MAT103
CREDIT - 5 (1/0/2)

PREREQUISITES - Mathematics 1, Mathematics II

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the course "Mathematics-III" is to form the basic knowledge and skills through a high level of understanding of the sections of the course, which will help to analyze and solve theoretical and practical problems.
Objectives of the course: to teach students to read textbooks independently, to conduct theoretical and probabilistic and statistical analysis of applied problems; development of logical thinking and increase the general level of mathematical culture.

BRIEF DESCRIPTION OF THE COURSE
The course "Mathematics-III" includes the following sections: series theory, elements of probability theory and mathematical statistics, and is a logical continuation of the discipline "Mathematics II".

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Students must know:
- number series theory;
- Theory of functional series;
- Fourier series;
- Elements of probability theory and mathematical statistics;
need to know:
- solve problems on all sections of the theory of series;
- find the probability of events;
- find the numerical characteristics of random variables;
- the use of statistical methods for the processing of experimental data.

**PhysicsI, II**
CODE - PHY111-112
CREDIT - 5 (1/1/1)

PREREQUISIT - diagnostic test / PHYS110-111

PURPOSE AND TASKS OF THE COURSE
The main purpose of teaching Physics I and Physics II is to form ideas about the modern physical image of the world and the scientific worldview.

BRIEF DESCRIPTION OF THE COURSE
Physics I and Physics II are the basis of theoretical training and engineering activities of graduates of higher technical schools and form the basis of physical education required for an engineer working in the world of physical laws. The course "Physics 1" consists of the following sections: Physical bases of mechanics, Structure and thermodynamics of matter, electrostatics and electrodynamics. The subject "Physics II" is a logical continuation of the discipline "Physics 1" and forms a holistic understanding of the general course of physics as one of the basic components of the general theoretical training of bachelors in engineering. The subject "Physics II" includes the following sections: magnetism, optics, nanostructures, basics of quantum physics, atomic and nuclear physics.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Students will be able to apply knowledge of fundamental laws, theories of classical and modern physics, as well as the use of methods of physical research as the basis of the system of professional activity.

**Modern history of Kazakhstan**
CODE - HUM100
CREDIT - 5 (1/0/2)

PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE
The purpose of the course is to acquaint students of technical specialties with the main theoretical and practical achievements of domestic historical science on the history of modern Kazakhstan, a comprehensive and systematic study of the main stages of formation and development of Kazakhstani society.
- Analysis of the features and contradictions of the history of Kazakhstan in the Soviet period;
- to reveal the historical content of the basics of the laws of political, socio-economic, cultural processes in the period of formation of an independent state;
- to promote the formation of civic principles of students;
- Educate students in the spirit of patriotism and tolerance, belonging to their people and homeland.

BRIEF DESCRIPTION OF THE COURSE
The course of modern history of Kazakhstan is an independent subject and covers the period from the beginning of the twentieth century to the present day. The modern history of Kazakhstan studies the national liberation movement of the Kazakh intelligentsia in the early twentieth century, the period of formation of the Kazakh ASSR, as well as the process of formation of a multinational society.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Students must know:
- Knowledge of events, facts and phenomena in the modern history of Kazakhstan;
- Knowledge of the history of ethnic groups living in Kazakhstan;
- knowledge of the main stages of formation of the Kazakh statehood;
- be able to analyze complex historical events and predict their further development;
- Ability to work with all types of historical data;
- Ability to write essays and scientific articles on national history;
- Ability to work with historical concepts;
- ability to discuss;
- skills of self-analysis of historical facts, events and phenomena;
- public speaking skills.

**Kazakh / Russian language**
CODE - LNG104
CREDIT - 5 (0/0/3)

PREREQUISIT - diagnostic test

PURPOSE AND TASKS OF THE COURSE
- to teach students to listen to words on certain topics related to home, study, leisure;
- understand texts on personal and professional topics, including the most common words and phrases;
- be able to talk about everyday topics; describe their experience; to express one's opinion; narrate and evaluate the content of the book read, the film seen;
- be able to compose simple texts on specific topics, including professional activities.

BRIEF DESCRIPTION OF THE COURSE
The language material of the course is chosen so that the student has a lexical and grammatical minimum and is able to get acquainted with typical communicative situations, and in such cases can correctly assess them and choose the appropriate model (strategy) of speech behavior.
At the same time, the main emphasis is on learning to use the language learned in the implementation of various types of speech activities, such as reading (if understood), listening (in that case) and the production of texts of a certain complexity with a certain degree of grammatical and lexical accuracy.
The material for the lessons was selected so that students could master the basics of grammar (phonetics, morphology and syntax) and speech comprehension on the basis of simultaneous repetition of the Kazakh / Russian language, gradually complicating reading, writing and tasks.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
By the end of the first semester, the student acquires skills in accordance with the European level of A2 (Threshold according to the Alte classification), ie on the threshold of the level of independent language proficiency, with active organization of work in classes and honest performance of homework.

**English**
CODE - LNG108
CREDIT - 5 (0/0/3)

PREREQUISIT - diagnostic test / LNG1081-1086

LNG1081
PURPOSE AND TASKS OF THE COURSE
"English 1" The subject of English language is primarily intended for reading from scratch. This course is also suitable for people with a general knowledge of the language. After passing this level, the student will be able to communicate confidently on the main topics of English, know the basics of grammar and lay a certain foundation that will allow them to improve their skills in the next stage of learning English.
Postrequisites of the course: Elementary English 2.

LNG1082
PURPOSE AND TASKS OF THE COURSE
The subject "English 2" is the development of students' receptive skills (reading and listening) and productive skills (writing and speaking), analysis of basic knowledge, application and memorization of basic grammatical rules, mastering the features of pronunciation and simple vocabulary, as well as independent reading and The basis of learning English, aimed at stimulating critical thinking.
Prerequisites of the course: Beginner.
Postrequisites of the course: General 1.

**Physical education**
CODE - KFK 101, KFK 102, AAP122, AAP132
CREDIT - 2 (0/0/2)

PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE
During the course the student learns the basic elements of athletics, sports, gymnastics and skills of general physical training, including professional-applied physical training or a set of standards for a sport, the practical use of methods of independent physical education.

BRIEF DESCRIPTION OF THE COURSE
Basic knowledge and skills in the field of physical culture and sports, as well as methods of creating and normalizing the load during individual lessons; methods of creating hygienic gymnastics complexes and general development exercises are offered;
The final stage of the course is to meet the established standards for multiple-choice testing and / or general physical education, sports and vocational training.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
At the end of the course the student understands the role of physical culture and a healthy lifestyle; knowledge of the basics of physical culture and a healthy lifestyle; master a system of practical skills and abilities that provide maintenance and strengthening of health, development and improvement of psychomotor abilities and qualities.
The student must know:
- Rehabilitation with physical exercises and dosing during exercise;
- assessment of the volume and intensity of physical activity, taking into account age and health;
- use of methods and tools of PPFP;
- Use of KPO, SFP training complex and inclusion of sports and movement games, national games.
At the end of the course the student should know:
- goals and objectives of physical culture;
- The content of training sessions;
- Rules for creating and normalizing the load during individual lessons; - rules and methods of creating a set of hygienic gymnastics and general development exercises;
- direction of professional and applied physical training;
- A set of exercises on KPO, SFP and the content of games used in practical lessons.

**Philosophy**
CODE - HUM132
CREDIT - 5 (1/0/2)
PREREQUISITES - History of modern Kazakhstan

PURPOSE AND TASKS OF THE COURSE
The purpose of the course is to form cognitive, operational, communicative, self-learning competencies to solve problems:
- to promote the development of adequate worldviews in the modern world;
- formation of creative and critical thinking skills of students;
- Distinguish the relationship between spiritual and material values, their role in the life of man, society and civilization;
- to help you determine your outlook on life and seek harmony with the outside world.

BRIEF DESCRIPTION OF THE COURSE
"Philosophy" is the formation of a holistic worldview developed in the context of socio-historical and cultural development of mankind. Introduction to the basic paradigms of teaching philosophy and educational methodology in the classical and postclassical traditions of philosophy. Philosophy is designed to develop sustainable life instructions, to get its meaning as a special form of spiritual production. Contributes to the formation of a moral image of a person with the ability to think critically and creatively. The theoretical sources of this course are the concepts of Western, Russian and Kazakh scientists on the history and theory of philosophy.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
- know the basic terms, basic concepts and problems of philosophy;
- know the basic philosophical approaches to solving ideological problems in the context of culture;
- be able to analyze the history of the development of philosophical thought;
- be able to identify and address alternative issues in the history of human development;
- be able to identify the main theoretical approaches to the relationship between man and society;
- mastering the methods of independent work;
- ability to organize material;
- skills of free discussion and rational decision-making.

**Life safety**
CODE - SNE451
CREDIT - 2 (1/0/0)
REQUIREMENTS: no

PURPOSE AND TASKS OF THE COURSE
The purpose of the discipline: to study the impact of anthropogenic threats and risks that disrupt the normal life of people, cause accidents, emergencies and disasters, including environmental disasters. To develop the skills to identify these threats and master the principles of preventive measures or protection against them.

BRIEF DESCRIPTION OF THE COURSE
Life safety deals with the identification of hazards and threats that affect human health and life. Life safety gives an idea of the integral unity of effective professional activity with the requirements for human safety and security. Basic principles of safety of life, safety of human interaction with the environment; rational and safe conditions of its activity; includes the study of the effects of traumatic, harmful and damaging factors on humans; technical means and technology explores the tools and methods to improve the safety, environmental friendliness and sustainability of agricultural processes.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Monitoring the level of adverse effects on students and their compliance with regulatory requirements; effective use of protection against adverse effects; development of measures to improve the safety and environmental friendliness of production activities; acquaintance with the planning and implementation of measures for the protection of production personnel and the population.

**Information and communication technologies**
CODE - CSE677
CREDIT– 5 (2/1/0)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE

Training in the use of modern information technology in the field of professional activity. This course includes:

- Discover the basic concepts of computer system architecture;
- Discover the basic concepts of information and communication technologies and subject terminology;
- Learning to work with software interfaces of operating systems;
- Learning to work with data in different forms, tabular and non-structural;
- Learning to apply the basic principles of information security;
- Explain the concepts of data formats and multimedia content.
- Learning to work with standard multimedia data processing applications. Use of modern methods of presentation of the material;
- Discover the concept of modern social, cloud and mail platforms and ways to work with them;
- To teach to use algorithmic and programming methods to solve problems of automation of business processes.

BRIEF DESCRIPTION OF THE COURSE

The course includes a training program aimed at leveling the basic knowledge of students in the field of information and communication technologies. It contains a full set of priority topics for the development of practical skills in working with data, algorithms and programming in accordance with the SES Standard Curriculum. The course is designed to teach students not only the basic concepts of architecture and modern infrastructure of information and communication technologies, but also the use of these tools to solve applied problems. To teach to optimize processes, to use appropriate models and methods of solving practical problems using modern methods and tools of information technology, to automate daily processes, to be productive and efficient.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

Students will know:

Computer device;

Architecture of computer systems;

Information and communication technology infrastructure;

Interfaces of modern operating systems;

Modern tools for working with data of different nature and purpose;

Types of information security threats, principles, tools and methods of data protection; - Python programming language.

Students can do the following:

Work with interfaces of modern operating systems;
Work with modern application software to work with data of different nature and purpose;
Use of modern social, cloud, e-mail platforms for the organization of business processes;
Programming in the algorithmic programming language;
Analysis, modeling, design, implementation, testing and evaluation of information and communication technologies.

**Political science**
CODE - HUM128
CREDIT - 2 (1/0/0)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE
The purpose of the course is the political socialization of students of technical universities, the political aspect of training highly qualified specialists on the basis of modern world and domestic political thought.
The purpose of the course is to provide the future specialist with a basic theoretical knowledge that will be a theoretical basis for understanding political processes, the formation of political culture, the formation of personal positions and a clear understanding of their responsibilities.

BRIEF DESCRIPTION OF THE COURSE
The course of political science provides students with the basics of political science and to form a general idea of the policy, its main aspects, problems,
interaction and regularities with other spheres of public life.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
At the end of the course the student should know:
- The basic conceptual apparatus of political science;
- The main methodological approaches and paradigms of political science
- system of power relations
The student must know:
- analysis of the features of political systems and the activities of political institutions;
- critical assessment of theoretical approaches to political science;
- Comparison of international and subnational political systems, institutions and actors on the basis of acquired knowledge and methods;
- development of proposals and recommendations to public authorities.
Formation of critical thinking skills and the ability to apply it in practice. Formation of skills to describe and analyze current issues of modern society, the essence of social processes and relationships.

**Cultural studies**
CODE - HUM129
CREDIT - 2 (1/0/0)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE

The purpose of the course:

Understanding of the peculiarities of the development of domestic culture in the context of world culture and civilization, the need to preserve the cultural code of the Kazakh people, the formation of the ability to independently pursue strategies for preserving the cultural heritage of the Kazakh people in a rapidly changing multicultural world and society.

Course objectives:

- description of morphology and anatomy of culture as a system of parameters and forms in context:
- nature, man, society;
- interpretation of the origin and meaning of signs, meanings, archetypes, symbols as a system of cultural codes by linking them with the type of material culture, a certain way of being;
- Regulation of information about the cultural heritage of the people of Kazakhstan and identification of channels for their influence on the formation of the culture of the Kazakh people;
- analysis of the cultural capital of the Turks, regulation of forms and channels of cultural interaction with the peoples of Western Europe, the Middle East, identification of their contribution to the intellectual and cultural history of mankind and the Kazakh people;
- Substantiated and substantiated provision of information on various stages of development of Kazakh culture as a factor of preservation of cultural heritage and the Kazakh language, including modern state programs for its development and modernization;
- objective assessment of the national cultural heritage.

BRIEF DESCRIPTION OF THE COURSE

The course is aimed at students of all specialties in the field of "Cultural Studies", the development of socio-humanitarian worldview as a basis for the modernization of public consciousness through the formation of cultural identity, the ability to analyze and evaluate cultural conditions based on understanding the nature of cultural processes, cultural objects, the role of cultural values in intercultural communication.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

During the course the student learns the practical application of methods of cultural studies in various aspects of life. Basic knowledge and skills in the field of philosophy and cultural studies, as well as methods of comparing, analyzing, synthesizing, solving situations through dialogue.

At the end of the course the student should know:

- Information on the cultural heritage of the people of Kazakhstan and identify channels of their influence on the formation of the culture of the Kazakh people;
- classification of cultural capital of Turks, regulation of forms and channels of cultural interaction with the peoples of Western Europe, the Middle East, identification of their contribution to the intellectual and cultural history of mankind and the Kazakh people;
- Substantiated and substantiated presentation of information on various stages of development of Kazakh culture as a factor of preservation of cultural heritage and the Kazakh language, including modern state programs for its development and modernization.

**Ecology and sustainable development**
CODE - CHE452
CREDIT - 2 (1/0/0)
PREREQUISITES: no

PURPOSE AND TASKS OF THE COURSE
The purpose of the course: the formation of knowledge about modern global environmental issues and ways of sustainable development of mankind, the biosphere capacity of economic development of civilization, the principles and methods of sustainable development of mankind.
Course objectives:
- to understand the causes of the emergence and development of modern environmental problems;
- mastering a systematic and integrated approach to solving modern environmental problems;
- mastering practical skills for the development and implementation of long-term environmental programs for sustainable development of civilization.

BRIEF DESCRIPTION OF THE COURSE
The main research subject of global ecology is the biosphere. The biosphere is a single system with many synergistic effects, which explains its function and role in supporting life on Earth. The biosphere is open to other spheres and freely exchanges substances, energy and information with these spheres. However, the sharp increase in human activity has reached a level that affects the biosphere and has a significant impact on global cycles and flows, such as climate change, global pollution, biodiversity catastrophe and other global problems of our time. The solutions to these problems are presented for the purposes of sustainable development.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Environmental problems of the present period and ways to solve them in accordance with the goals of sustainable development.
QUALIFICATION:
Finding the causes of modern environmental problems and their prevention, planning and solution.
SKILLS:
- Assessment of the state of the environment in the face of global change;
- Analysis of the main stages of civilization in terms of global ecology;
- Mastering practical skills to adapt to global change and achieve sustainable development.

**Sociology**
CODE - HUM127
CREDIT - 2 (1/0/0)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE

The purpose of the course: the formation of theoretical knowledge about society as an integrated system, its structural elements, connections and connections between them, the features of their activities and development, as well as existing sociological theories that explain social phenomena and processes.

Objectives of the discipline:

- study of the basic values of social culture and readiness to learn them in their personal, professional and general cultural development;
- to study and understand the laws of development of society and be able to work with this knowledge in professional education;
- the ability to analyze socially important issues and processes, etc.

BRIEF DESCRIPTION OF THE COURSE

The course is designed to improve the quality of general humanitarian and professional training of students. Knowledge in the field of sociology is the key to effective professional activity of the future specialist, which is impossible without understanding the social processes in modern society, as well as the skills to interpret them correctly.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

As a result of studying the discipline the student:

know:

• features of the sociological approach to the interpretation of the basic concepts and terms of the social sciences;
• basic classical sociological theories and schools;
• basic concepts of sociology: society, group, socialization, social facts and social actions, norms, values, social structure, mobility, culture, social institution, social organization, social process, etc .;
• basic methods of identifying and analyzing the social structure of society, social changes;
• basic laws of social processes and mechanisms of functioning of the main social associations;
• regularities of socio-economic, political and managerial processes, the main methods of their study, as well as the peculiarities of their application;

can do:

• describe the processes and phenomena observed in society using sociological terminology;
• explain the differences in the methods of defining sociological concepts;

• considers social phenomena, institutions and processes from different points of view, proves its position on the issue by comparing and contrasting some theoretical perspectives;
• discover, analyze and present factual data, analytical information about social groups, institutions, processes and phenomena, revealing abstract concepts, using examples, using different types of data;
masters:
• be able to apply sociological knowledge in practice to analyze the phenomena and events of social reality;
• personal training, constructive communication and skills to play appropriate roles in the implementation of group projects, participation in discussions;
• presentation of the results of individual and group analysis in writing and orally;
• academic and grammatical writing skills, text structuring, source processing, reference design.

**Theoretical bases of electrical engineering**
CODE - ELC541
CREDIT - 5 (2/1/0)

PREREQUISITES - Physics I

PURPOSE AND TASKS OF THE COURSE
To teach students to choose the elements of the theoretical foundations of electrical engineering, the principles and methods of calculation of electrical circuits, the scientific basis and current state of electrical engineering. It deepens and develops the training of engineers with modern construction and computing technology, as well as the selection of electrical equipment.

BRIEF DESCRIPTION OF THE COURSE
Discipline is considered: the basic concepts and definitions used in electrical engineering; modern methods of modeling electromagnetic processes; methods of analysis of electrical and magnetic circuits; numerical methods of analysis of electrical circuits; Basic laws and principles of electrical engineering, properties and characteristics of electrical circuits; methods of analysis of electrical circuits in constant and variable modes; selection of the optimal method of calculation, determination of the basic parameters and characteristics of electrical circuits.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
The course "Theoretical Foundations of Electrical Engineering" provides students with knowledge about electrical and magnetic phenomena and their use for practical purposes and provides comprehensive training of future professionals: high professional level, development of creative abilities, ability to formulate and solve problems at a high scientific level; be able to apply and solve independently.

**Computer modeling and programming in MatLab**
CODE - AUT423
CREDIT - 5 (1/2/0)

PREREQUISITES - Mathematics I-III

PURPOSE AND TASKS OF THE COURSE

There are two types of program research written in MATLAB - functions and scripts. Functions have input and output arguments, as well as a separate workspace for storing the results of intermediate calculations and variables. Scenarios use a common workspace. Both scripts and functions are stored as text files and are dynamically compiled into machine code. You can also save pre-parsed programs and scripts to make them easier to run on the machine. Simulink's research is also designed to model, model, and analyze dynamic systems that allow you to create graphical block diagrams, model and analyze dynamic systems, study system performance, and improve projects. Such a wide range of opportunities allows Simulink in various fields: physics, mathematics, biology, economics, medicine, etc. b., allows you to use tasks where they are characterized by mathematical and logical operations.

BRIEF DESCRIPTION OF THE COURSE

MATLAB supports numerical and symbolic approaches to modeling and provides data approximation, statistical computation, optimization, solving simple differential equations (ode) and semi-differential equations (PDE), differential and integral calculus, and other basic mathematical tools. Simulink provides additional conditions for modeling and modeling the behavior of multi-domain systems, as well as the development of embedded systems.

Using MATLAB, programs and algorithms can be written faster than traditional programming languages, as there is no need for low-level organizational operations such as declaring variables, defining types, and allocating memory. In many cases, the transition to vector and matrix operations eliminates the need to use for loops. As a result, one line of MATLAB code can often replace several lines of C / C ++ code.

MATLAB has the properties of traditional programming languages, including data flow management, error handling, and object-oriented programming (OOP). You can use basic data types, complex data structures, or define individual types.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

Studying MATLAB gives students many (several hundred) opportunities to analyze data covering all areas of mathematics:

Matrices and linear algebra-algebra of matrices, linear equations, eigenvalues and vectors, singularities, factorization of matrices and others.

Polynomials and interpolation - roots of polynomials, operations of polynomials and their analysis, interpolation and extrapolation of curves and others.

A set of special functions, including data processing, graphing, optimization, zero search, numerical integration (squaring) and more.

Differential equations-Solution of differential and differential-algebraic equations, delay differential equations, finite equations, semi-derivative equations and others.
Rare matrices are a special class of MATLAB packages used in specialized applications.
Integer arithmetic - performing integer arithmetic operations in the MATLAB environment.

**Fundamentals of Entrepreneurship, Leadership and Anti-Corruption Culture**
CODE - MNG487
CREDIT - 3 (1/0/1)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE

Formation of systematic knowledge of the basics of business organization. Development of organizational and managerial skills in business. Formation of knowledge about the responsibility of business entities, student aesthetic concepts and categories, the content and features of professional ethics in legal practice, possible ways (methods) of resolving moral conflicts in the professional activity of a lawyer, the essence of professional and moral deformation and ways to prevent and overcome them; know its basic norms and functions; be able to ethically assess the facts and phenomena of professional activity, the application of moral rules and norms of behavior in real life situations.

BRIEF DESCRIPTION OF THE COURSE

The course is aimed at students to form the organizational and legal form of the enterprise on the basis of the goals of the enterprise and the peculiarities of the organization and operation of enterprises of various forms; assessment of business efficiency; assessment of external and internal risks for the enterprise; development of business plans taking into account regulatory, resource, administrative and other conditions. Setting goals and formulating tasks related to the implementation of professional functions. Organization of team interaction to solve managerial tasks. Diagnosis of organizational culture, identification of its strengths and weaknesses, development of recommendations for its improvement. Development of measures to motivate and motivate the staff of the organization.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

Must know: business typology; the role of the environment in business development; business decision-making technology; basic components of the internal environment of the firm; organizational and legal forms of business activity; features of constituent documents; The order of state registration and licensing of the enterprise; mechanisms of operation of the enterprise; the essence of business risk and the main ways to reduce risk; basic elements of business culture and corporate culture; list of data to be protected; essence and types of responsibility of entrepreneurs; methods and tools of financial analysis; basic rules of accounting in small enterprises; types of taxes; system of business efficiency indicators; principles and methods of assessing the effectiveness of entrepreneurial activity; ways to increase the efficiency and control of business activities.

Must be able to: describe the types of business activities and the business environment; work with economic categories in practical activities; business plan development; compile a package of documents to open your own business; execution of documents for opening a current account in a bank; determination of the organizational and legal

form of the enterprise; development of strategy and tactics of the enterprise; observance of professional ethics, ethical codes of the firm, generally accepted rules of doing business;
Skills of students to master the scientific and legal framework for the organization and conduct of business in the Republic of Kazakhstan; study of its features, problems and prospects for development in Kazakhstan.

**Psychology**
CODE - HUM122
Credit - 2 (1/0/0)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE

The purpose of the discipline - the formation of psychological knowledge, skills and abilities necessary for professional activity; development of students' psychological thinking and systematization of their knowledge on the basis of studying the general psychological laws.

Objectives of the discipline:

1) mastering the basic psychological concepts, theories and methods of studying the individual and society;

2) the formation of an understanding of the basic principles of functioning of socio-psychological phenomena, the psychological age and cultural socialization of man, the factors of his learning and cognitive development;

3) the formation of skills to apply the knowledge acquired in the process of mastering psychology in professional activities.

4) creative development of skills and abilities of analytical and research thinking, the content of psychological sources of foreign and domestic authors and methods of obtaining psychological information;

5) the formation of critical thinking skills and the ability to apply it in practice.

BRIEF DESCRIPTION OF THE COURSE

The subject "Psychology" studies the laws of origin, development and functioning of mental processes, states, personality traits that are engaged in certain activities, the laws of development and functioning of the psyche as a special form of life. The study of this discipline is aimed at the formation of psychological culture, worldview, self-knowledge, psychological thinking of the individual for social and professional interaction.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

As a result of studying the discipline the student:

know:

- description of psychology as a science, its methods, tasks and history of development;
- the essence and structure of the emergence and development of the psyche and mental phenomena, taking into account the age and social characteristics of the scene;
- General psychological patterns of development of psychological phenomena;
- knowledge of the psychological laws of human relations and relationships;
- dynamics of development and structure of individual and human activity;

can do:

- to understand and explain the need for psychological and socio-psychological education in professional activities;

- Analysis of the main categories of psychology, interpersonal relationships in the group, the peculiarities of the behavior of different individuals;
- use psychological knowledge as a tool for self-knowledge and self-development;
- designing effective methods of work in various fields of social relations, based on the content of psychological theories and ideas;
masters:
- Evidence-oriented skills aimed at achieving high results of educational and professional activity.
- ability to work in a team, to defend one's point of view, to propose new solutions, to compromise;
- skills of systematic thinking and holistic perception of psychological reality;
- be able to analyze and make judgments about the psychological problems of man in the current state of society.

**General chemistry**
CODE - CHE495
CREDIT - 5 (1/1/1)

PREREQUISITES - School chemistry course, mathematics, physics.

PURPOSE AND TASKS OF THE COURSE

To develop knowledge on the basic problems of general chemistry and skills to apply them in professional activities.

The main objectives of the study of the discipline include the following:

- study and master the theoretical material of the course in lectures and in the process of independent work;
- formation of skills in solving chemical problems and problems in practical classes and independent work;
- to acquire skills in conducting chemical experiments and processing its results during laboratory work and independent work in the preparation of reports.

BRIEF DESCRIPTION OF THE COURSE

Chemistry is one of the fundamental scientific disciplines and plays an important role in scientific and technological progress. It describes the world at a certain level of the structure of matter. Understanding the problems and processes at the atomic-molecular level is necessary for any professional engineer, as he must work with different substances, materials and chemical reactions. Like any basic science, it is equipped with special (in this case - chemical) problem-solving techniques.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

Upon completion of the discipline "General Chemistry" the student must be able to:

- application of knowledge, skills, abilities and competencies acquired in the study of general scientific and special disciplines related to chemical disciplines;
- apply the acquired knowledge, skills, abilities and competencies in solving production and technological problems;
- be able to make calculations based on the results of the experiment.
  The student must know:
- theoretical methods of describing the properties of simple and complex substances on the basis of the electronic structure of their atoms and their place in the periodic table of chemical elements;
- basic methods of studying physical and chemical phenomena.

**Basics of electronics**
CODE - ROB502
CREDIT - 5 (1/1/1)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE
The purpose of the course is to form students' knowledge of the basics of electronics, methods of calculation and design of electronic devices.
Objectives of the course - to master the basics of physical operation and devices of semiconductor devices, as well as their characteristics and performance, as well as the basic principles of analog circuits, signal generators, principles of integrated circuits, functions and construction of integrated logic elements, combinatorial and know the methods of synthesis of logic devices of chain type.

BRIEF DESCRIPTION OF THE COURSE
It is necessary to acquire skills and knowledge to read the basic and block diagrams of electronic devices, to know the principles of their operation and to be able to correctly select the elements of electronic equipment.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
- structural features and principle of operation of electronic devices;
- physical phenomena in electronic devices;
- basic characteristics of electronic devices;
- analysis and study of physical phenomena in electronic circuits.
Must be able to:
- experimental determination of the characteristics and performance of devices and electronic devices;
- measurement of electrical quantities in semiconductor devices;
- be able to read and understand the design of electronic nodes, simple circuits of typical electronic equipment.

**Robotic production technology**
CODE - ISO160
CREDIT - 5 (2/1/0)
PREREQUISITES - Physics I

PURPOSE AND TASKS OF THE COURSE
The subject "Robotic Production Technology" aims to teach students the methodology of designing technological processes in the context of automated production, the independent development of technological processes for the assembly of machines and their parts.
The objectives of teaching the discipline are to obtain knowledge to ensure the accuracy, control and testing of engineering products.

BRIEF DESCRIPTION OF THE COURSE
The scientific basis of engineering technology, the principles of design of technological processes in the conditions of preparation of robotic production, selection of blanks, automation are considered.
As a result of studying the discipline, the student will be able to: design stages of machine production technology, standard technological processes for the manufacture of machine parts; know the equipment and accessories used in robotic production.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Setting and solving tasks of technical preparation of production; development of technological processes for the production of machines and parts of the required quality in the conditions of robotic production.

**Technological objects of automation**
CODE - CHE198
CREDIT - 5 (2/1/0)
PREREQUISITES - Physics I

PURPOSE AND TASKS OF THE COURSE
Objectives of teaching the discipline is to master the current state of the oil and gas industry of Kazakhstan and the world and the problem of raw materials. Modern and perspective requirements to the quality of motor fuel: the role, importance, directions of improving technological processes.

BRIEF DESCRIPTION OF THE COURSE
The state and main trends of the oil refining and petrochemical industry in the world and in Kazakhstan. Deepening of oil refining and its rational use. Improving and optimizing the quality of petroleum products. Improving the selectivity in the introduction of new advances in catalysis, the development of perfect and intensive technologies for deep processing of oil and oil products without waste and environmental damage. Effective technologies for catalytic and thermo-destructive treatment of heavy oil wastes. Perspective complex schemes and technologies of oil and gas refining.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
As a result of studying the discipline, the student learns: the essence of the fuel and energy complex in the world economy; Must know the basic technological processes of large tonnage production of oil and oil waste processing
Must be able to: Set and solve scientific and practical problems in the processing of oil and crude oil; creation of flow schemes and complexes for oil refining by physicochemical and fractional composition.

## Mathematical bases of control theory

CODE - AUT413
CREDIT - 5 (2/0/1)
PREREQUISITES - Physics II

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline is to continue and deepen the mathematical training of students, to expand the education system:
- when solving problems arising in the development, creation and study of complex control systems;
- as a general basis for teaching profile subjects.
Objectives of teaching the discipline are to master the theoretical foundations and practical skills in the following areas:
- methods of creating mathematical models;
-study of control systems based on the use of mathematical apparatus of continuous, discrete, fast Fourier transform, Laplace continuous and discrete transformation, Z-transform series

BRIEF DESCRIPTION OF THE COURSE
The course continued and deepened the mathematical training of students and methods of creating mathematical models; methods of linearization of models; Description of the model in the form of differential equations; characteristics of linear models; Fourier series; Decomposition of a function in the Fourier series; Fourier integrals; continuous, discrete and fast Fourier transform; Continuous and discrete Laplace transform; Z-Fourier transform; Z-Fourier transform; Z-Fourier transform; Z-Fourier transform; Z-Fourier

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Automatic control system; management system tasks; classification of management systems;
methods of creating mathematical models; methods of linearization of models; description of the model in the form of differential equations; characteristics of linear models; Fourier series; decomposition of a function into a Fourier series; Fourier integrals; continuous, discrete and fast Fourier transform; Continuous and discrete Laplace transform; Z-conversion.
Skills and abilities: Problem solving and solving problems using mathematical devices of the Fourier series; Fourier continuous and discrete transformations; Laplace continuous and discrete transformations; Z-conversion.

**Linear automatic control systems**
CODE - AUT411

CREDIT - 5 (1/1/1)
PREREQUISITES - Mathematical bases of management theory
PURPOSE AND TASKS OF THE COURSE
The purpose of the course is to train a specialist who has a deep knowledge of the basics of the theory of automatic control and can perform computational work on the creation of automatic systems with the widespread use of modern computer technology.
Objectives of the course are to study the problems of analysis and synthesis of automatic control systems (ACS), the development and study of object models in the temporal, complex and frequency domains, methods of analyzing the stability of network systems, quality assessment of control processes.

BRIEF DESCRIPTION OF THE COURSE
The training course includes sections of management theory related to the tasks of analysis and synthesis of linear control systems. Including: - principles and schemes of automatic control; mathematical description of control systems in the temporal, complex and frequency domains; creation of temporal and frequency characteristics of automatic control systems; methods of studying the stability of network systems of automatic regulation and control; methods of assessing the quality of the regulatory process.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Knowledge acquired during the course:
- The basic principles and schemes of automatic control, the main types of automatic control systems, their mathematical characteristics and the main objectives of the study;
- methods of linear theory of systems, methods of analysis in the field of temporal, complex and frequency;
- creation of time and frequency characteristics of automatic control systems;
- methods of studying the stability of linear systems of automatic regulation and control;
- methods of assessing the quality of the regulatory process.
Skills and abilities acquired during the course (professional, managerial, communicative):
application of mathematical methods for the analysis of general properties of linear systems, management of methods of analysis and synthesis of linear control systems on this basis;
Possibility to analyze the stability and quality of systems, perform calculations on the synthesis of parameters and compensating elements in accordance with the established requirements for the quality of systems.

**Integrated and microprocessor circuitry**
CODE - ROB506
CREDIT - 5 (2/1/0)
PREREQUISITES - ROB 156

PURPOSE AND TASKS OF THE COURSE
The purpose of the discipline "Integrated and microprocessor circuitry" is to acquaint students with the basics of digital integrated circuitry and their practical application in instrument making.
Objectives of the discipline - to provide general information about the development of integrated digital circuits, programming and architecture of a typical microprocessor system, methods of design and automated modeling of electronic circuits.

BRIEF DESCRIPTION OF THE COURSE
The study of the discipline consists of the acquisition of basic logical elements, types of knowledge in the field of combinational circuits and complex microprocessor systems.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
A student must know: the principle of operation of digital integral elements, their classification, marking and graphical representation, methods of assembly and connection of complex devices, the function and composition of microprocessor devices and methods of their programming.
Must be able to - design digital nodes, including on the basis of microprocessor elements; reading and understanding of schematics; draw and read, understand functional diagrams; be able to select elements and microcircuits on the basis of reference information for the implementation of schemes; application of theoretical knowledge to solve problems related to the construction of digital and microprocessor systems and devices.

**Programming in Python**
CODE - CSE199
CREDIT - 5 (2/1/0)
PREREQUISITES - Computer modeling and programming

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching this course is to teach students a powerful tool for data processing, such as Python and SciKit libraries, which include working with matrices, SciPy - data analysis tools, MatplotLib - data visualization tools.

BRIEF DESCRIPTION OF THE COURSE
Python is currently recognized as the most common programming language in data processing tasks. This is due to its simplicity and intuitive syntax, in which the connection with the hardware part of the computer is abstracted, with an emphasis on the creation of small efficient algorithms. The course provides a quick tour of the syntactic features and strengths of the language.
Emphasis is placed on data processing mechanisms, such as: loading, filtering, transformation, analysis and interpretation, clustering, regression, etc., using known classification models. The basic methods of working with matrices and matrix operations are studied on the basis of the NumPy library. MatPlotLib is a tool for visualizing data in the form of various graphs, which allows you to analyze the operations performed, the results of calculations or understand the nature of the data.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Upon completion of the course, students will gain the necessary knowledge of the Python language. Learn how to program matrix operations and work with data. Learn how to download, filter, edit, and interpret data. Learn to use data analysis models such as classification, clustering, regression. You will learn to use effective techniques when writing program code in Python.

**Nonlinear automatic control systems**
CODE - AUT416
CREDIT - 5 (1/1/1)
PREREQUISITES - Network control systems

PURPOSE AND TASKS OF THE COURSE
The purpose of the course is to train a specialist who knows the basics of the theory of nonlinear automatic control and can perform computational work on the construction of nonlinear automatic systems with the widespread use of modern computer technology. Objectives of the course - to study the principles of automatic control (NSAR) and nonlinear control systems, standard nonlinear modeling, methods of analysis of the stability of nonlinear systems, analysis and synthesis of pulse systems.

BRIEF DESCRIPTION OF THE COURSE
The NSAR training course includes sections on control theory related to the analysis and synthesis of nonlinear and pulse systems. Including: study of important features of nonlinear systems; mastering mathematical models in state space; exact and approximate methods of analysis of stability of nonlinear systems - phase plane method, Lyapunov's second method, harmonic linearization method, Goldfarb criterion, criteria for self-oscillation detection (Mikhailova, Gurvitsa); basic concepts of pulse systems, mathematical models of pulse systems; study of stability and quality of pulse systems.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Knowledge acquired during the course:
- Fundamentals of the theory of nonlinear systems: methods of mathematical description and modeling, important properties, types of nonlinear systems;
- Methods for studying the stability of periodic modes and transients in nonlinear systems;
- Methods of describing discrete systems: mathematical description, methods of studying the stability and quality of regulation.
Skills and abilities acquired during the course (professional, managerial, communicative):
- use mathematical methods to analyze the general properties of nonlinear systems, on this basis to master the methods of analysis of nonlinear automatic control systems;
- perform calculations to analyze the stability of nonlinear systems;
- Perform basic computational work on the study of nonlinear systems of automatic control.
- perform calculations to analyze the stability and quality of pulse systems.

**Intelligent process control systems**
CODE - AUT408
CREDIT - 5 (1/2/0)
PREREQUISITES - Linear automatic control systems

PURPOSE AND TASKS OF THE COURSE
The course is designed for undergraduate students majoring in "Automation and Robotics". The purpose of teaching the subject "Intelligent systems of automatic control" is the theoretical and practical training of students in the application of artificial intelligence methods and technologies in control systems.
Methods and tools of artificial intelligence reach and reach the consumer in the form of Intelligent Technologies, which do not change in a particular problem area. This program is designed to address the practical application of modern intellectual technologies. Traditionally, these include fuzzy logic, genetic algorithms, and neural networks.

BRIEF DESCRIPTION OF THE COURSE
The course "Intelligent systems for process control" contains the following sections: classification of expert systems; basics of fuzzy set theory; Basics of creating fuzzy output systems for management purposes; field of application of neural networks; properties of neural networks; algorithms for learning neural networks; basics of the theory of genetic algorithms; classification of intelligent management systems (IMS); principles of operation of BBZ of different structure; basic methods of synthesis of Intelligent systems for optimal management of technological processes; know the methods of studying different types of intelligent algorithms.
The last stage of the course is the completion of the course work, which consists of 6 IWS, which must be submitted in accordance with the schedule during the semester.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
At the end of the course the student:
- formation of PFE planning matrices through a survey of experienced operator-technologists;
- Synthesis of algorithms (models) of optimal control of technological processes with the help of fuzzy algorithms;
- Synthesis of algorithms (models) of optimal control of technological processes with the help of neural networks;
- Synthesis of algorithms (models) of optimal control of technological processes with the help of neuro-ambiguous algorithms;
- study of intellectual models of management for adequacy, sensitivity, uniqueness and sustainability.

**Numerical methods in Matlab**
CODE - AUT190
CREDIT - 5 (2/1/0)
PREREQUISITES - Mathematics III

PURPOSE AND TASKS OF THE COURSE
Numerical methods play an important role in the system of applied mathematical education, in particular in the theory of control and modeling of technological objects and systems. The purpose of teaching the discipline is to study numerical methods for solving algebraic problems, mathematical analysis and differential equations, as well as methods for creating, classifying and analyzing mathematical models. Objectives of the course include: numerical methods of creating, solving and studying various problems, development and selection of optimal algorithms for solving specific problems, processing and analysis of results, correction of the solution method when there are features of the problem, analysis of solution stability and convergence, Matlab software package assessment of the scope of the mathematical model created using.

BRIEF DESCRIPTION OF THE COURSE
The course "Numerical Methods in Matlab" deals with approximate numbers and errors. Calculate the values of simple functions. Interpolation and approximation of functions. The best approximation. Spline interpolation. Search for roots of nonlinear equations. Iterative methods. Newton's method. Separation of roots. Complex roots. Solving systems of equations. Methods of calculation of linear algebra. Direct and iterative processes. Numerical analysis. Numerical integration. Numerical integration of fast oscillating functions. Multidimensional integrals. Cauchy problem for simple differential equations. Combining second and higher order equations. Numerical methods for solving boundary value problems and eigenvalues for simple differential equations. Difference schemes. Approximation. Stability. Accumulation. Variation-difference methods, the method of final elements. Numerical methods for solving integral equations. Calculation of false matrices and false matrices. Singular decay. Processing of experimental data using the software package Matlab.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Studying this discipline allows students to apply their knowledge in the optimal management and solution of practical problems of nonlinear systems, to create models of complex linear and nonlinear systems, to process experimental data.

**Numerical methods in Python**
CODE - AUT191
CREDIT - 5 (2/1/0)
PREREQUISITES - Mathematics, Python programming language

PURPOSE AND TASKS OF THE COURSE

The main purpose of the course is to teach students to master the methods of numerical solution of mathematical problems, their qualitative analysis, as well as the skills of independent implementation of numerical methods in Python.

Course objectives:

1. Development of numerical methods for solving algebraic problems, systems of nonlinear equations, the best approximations of functions and interpolations, study and assimilation of initial and boundary value problems for simple differential equations, equations of mathematical problems in Python;
2. a set of methods of quantitative analysis, the formation of a holistic view of the general methods of creating different methods;
3. mastering the methods of qualitative analysis before the use of quantitative methods;
4. To study the errors of numerical methods, methods of analysis of stability and convergence of numerical algorithms;
5. Mastering and improving the skills of program implementation of numerical methods.

BRIEF DESCRIPTION OF THE COURSE

Knowledge and correct application of numerical methods to solve mathematical problems that correspond to the model - one of the components of the process of computer modeling of physical processes. The subject "Numerical Methods in Python" forms the competence of students in this field. Teaching digital methods in modern MS Visual Studio, Matlab, etc. b. Python programming language using software packages.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

Mastering the subject "Numerical Methods in Python" should provide the formation of the following competencies:

To be able to choose the necessary method of computer modeling to solve mathematical problems in the subject area, to be able to implement nonlinear differential equations, semi-derivative equations and numerical algorithms for solving systems of equations in modern programming languages.

As a result of training the student should know:

- basic properties of floating point arithmetic;
- basic methods of quantitative analysis, conditions for solving standard problems and their application by numerical methods;
- main sources of inaccuracy of calculations;
- Create simple programs for the Windows platform and in the Matlab tool system or in the Python programming language;
- use the studied methods to solve problems of numerical modeling of physical processes;

- assessment of the accuracy of the numerical solution;
- quantitative analysis of physical and mathematical models;
- mastery:
- Simple programming skills in Python.

**Databases in control systems**
CODE - AUT407
CREDIT - 5 (2/1/0)
PREREQUISITES - Computer modeling and programming in the MatLab environment

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline is the theoretical and practical training of specialists who can choose a database management system, create and design a database, use them, explain the principles of their operation and choose the necessary solutions for their proper use.
Objectives of the course - to study students with scientific and engineering problems, methods and tools for creating and using databases; to teach students practical skills in designing, creating, maintaining a database, ensuring reliability.

BRIEF DESCRIPTION OF THE COURSE
Issues of creation and use of databases in management systems, organization of database management systems, principles of creation of information systems based on database models, database technologies, organization of call-interfaces for working with databases are considered. It also describes the features of creating a distributed database, data and information systems with a client-server architecture. The principles, concept and characteristics of the creation of object-oriented databases and warehouses are discussed.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Knowledge acquired during the course:
Basic schemes used in the design and use of modern databases, basic knowledge of data management systems, skills of working with Access and MS SQL Server database management systems, understanding the problems of the subject area, free navigation of basic database concepts and concepts.
Skills and abilities acquired during the course (professional, managerial, communicative):
Classify information processing problems when using different database management systems, work with relational algebras, create simple logic circuits for using relational database management systems, design database diagrams, create tables, enter and modify data, basic information retrieval in SQL commands formulate tasks.

**Information support of control systems**
CODE - AUT106
CREDIT - 5 (2/1/0)
PREREQUISITES - Mathematics I

PURPOSE AND TASKS OF THE COURSE
Objectives of the discipline: the formation of knowledge and competencies in the field of information support of control systems, the use of tools to obtain current information about technological objects, the use of microprocessor technology in control systems, the formation of a clear understanding of information flows in modern control systems.
Course objectives:

- Study of the theoretical foundations of information flows in control systems;
- study the principles of architecture, methods of obtaining information in control systems;
- study of hardware and software that provide information;
- to get acquainted with perspective directions of development of the theory and practice of information support of control systems.

BRIEF DESCRIPTION OF THE COURSE
The control system cannot function without information about the state of the controlled object (process) and the external environment. This course covers the hardware and software of control systems in terms of information flows, methods for determining the optimal amount of information included in the various devices for managing and distributing information flows in time and space, the necessary conditions for continuous and timely provision of all necessary information management systems.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Studying this discipline allows students to use modern hardware and software to create an optimal structure of the management information system. Determine the amount of information required in control systems and the rational distribution of information flows. The student learns the skills of working with real-time programmable logic controllers and Scada systems.

**Metrology and electrical measurements**
CODE - AUT192
CREDIT - 5 (1/1/1)
PREREQUISITES - Technical equipment of automation

PURPOSE AND TASKS OF THE COURSE
The purpose of the course is to study the basic types and block diagrams of information and measurement systems; Study of the most common types of interfaces used in information and measurement systems. Automation of complex production processes is characterized by the use of many measuring transducers that provide the required amount of measurement information and effective control of the technological process. The content of the course provides the basic definitions and terminology in the field of conversion of measurement information, methods of conversion of non-electrical quantities into electricity and the classification of converters, specific types of parametric and generator converters. The main characteristics that determine the scope of measuring transducers are given.

**Electrical measuring instruments**
CODE - AUT193
CREDIT - 5 (1/1/1)
PREREQUISITES - Physics, Higher Mathematics, Theoretical Foundations of Electrical Engineering

PURPOSE AND TASKS OF THE COURSE
This discipline deals with the measurement of technological parameters in the field of automation and control.
The content of the course provides the basic definitions and concepts in the field of conversion of measurement information. The methods of conversion of non-electrical quantities into electricity and the classification of converters are shown. There are specific types of transducers used to measure technological parameters. The main characteristics that determine the scope of measuring transducers are given.

Methods of optimization in the Matlab environment
CODE - AUT194-195
CREDIT - 3 (1/1/0)
PREREQUISITES - Mathematics I-III

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline is to study the methods of optimization and to master the practical skills of solving and applying these methods, depending on the specifics of the system.

BRIEF DESCRIPTION OF THE COURSE
Presentation of course material begins with the classification of optimization methods. Each type in the classification is described in detail, as well as the methods for these types. Optimization methods for linear systems, nonlinear systems, dynamic, deterministic and stochastic systems are studied.
Genetic Algorithms and their place in intellectual technology. Examples of the use of genetic algorithms.

KNOWLEDGE, SKILLS, SKILLS UNTIL COMPLETING THE COURSE
The student must know how to find the extremes of functions without the limitations and disadvantages of existing optimization methods. He must also be able to determine the characteristics of the system and what optimization method to apply to a particular system. To comply with this and to coordinate tasks to solve practical work skills. Practical application of genetic algorithms to solve optimization problems.

**Neuro-network automation technologies**
CODE - AUT196
CREDIT - 5 (2/1/0)
PREREQUISITES - Mathematics I

PURPOSE AND TASKS OF THE COURSE
Objectives of the discipline The formation of knowledge and competence in the field of application of neural network technologies to solve the problems of automation and control of technological processes and production; mastering the skills and abilities to design and use technical means and automation systems based on the use of neural networks and neural network control systems.
Objectives of the discipline:

- study the theoretical foundations of neural networks and neural control systems;
- study the principles of architecture, methods of teaching and testing neural networks and neural systems;
- mastering the use of methods for modeling neural networks and control systems of neural networks;
- acquisition of skills in the development and implementation of software models of neurocomputer systems;
- study the principles of hardware construction of neural networks and neural systems;
- acquaintance with perspective directions of development of the theory and practice of neural networks and neural control systems.

BRIEF DESCRIPTION OF THE COURSE
The course "Neural Network Automation Technologies" covers the basics of the theory of neural networks and neurocontrollers, which are necessary to understand the principles of neural network technology - a powerful tool for creating automation systems that are actively used in engineering practice in recent years. The basic structures of neural networks of regulators are studied, examples of solving real problems are considered. The features of the Matlab mathematical modeling package are used to analyze control systems and synthesize neural regulators, to create hybrid neural networks.
KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
The study of this discipline allows students to apply modern theoretical and experimental methods of developing mathematical models of objects and processes, set tasks for the design of software and hardware for automation and control, prepare technical tasks for design work, intelligent control based on neural and hybrid networks using standard software. allows you to develop systems, work with technologies and neural network packages to solve the problems of creating modern automation systems and tools; modeling and diagnostics of neural networks and neural systems.
**Industrial robot control systems**
CODE - AUT180
CREDIT - 5 (2/1/0)
PREREQUISITES - NO
PURPOSE AND TASKS OF THE COURSE

The purpose of teaching the discipline is to study the manipulators of industrial robots and process equipment, the design and computational features of modern designs of robotic systems, their location and structure, characteristics and requirements, conditions of use of different types of manipulators. production.

BRIEF DESCRIPTION OF THE COURSE
Use of industrial robots. Components of a robot cell. Control system configuration. Connecting peripherals. Security devices. Safety precautions when working with industrial robots. Starting the robot. Description and construction. Robot mechanics. Accuracy and repeatability. Robot control system. Bus systems. Control panel and its functions. The mode of operation of the robot. Universal coordinate system. Tool coordinate system. Basic coordinate system. Robot alignment. The appliance loads. The robot loads. Calibrate the instrument. Base calibration. Ask for the current location of the robot.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Graduate of the discipline:
Must know:
1. Special terms of industrial robotics
2. Methods of calibration and adjustment of industrial robots
3. Principles of programming industrial robots
Must know:
1. Find the necessary Internet resources on your own and learn to work with different resources
industrial robots.
2. Do your own IDE and development programs.
3. Deal with code snippets yourself.
Must own:
1. KRL programming skills.
2. Be able to write software modules for real production robots.
Must show ability and readiness:
1. Understand third-party applications of industrial robots.
2. Write programs in KRL independently.
3. Self-detection and correction of errors in the code in the KRL language.
4. Write software modules for real industrial robots.

**Neural network robotics technologies**

CODE - AUT197
CREDIT - 5 (2/0/1)
PREREQUISITES - Intelligent process control systems

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline "Neural network technologies of robotics" is to master the following competencies: methods, languages and models of knowledge presentation; design and development of expert systems; basics of artificial intelligence. The objectives of teaching the discipline are to prepare bachelors to independently conduct theoretical, experimental, design and implementation work in the field of modern information technology associated with the use of artificial neural networks.

BRIEF DESCRIPTION OF THE COURSE
Short course of discipline: Principles of creation of Intelligent systems of control of mobile robots. Information and measurement system of intelligent mobile robots with visual feedback. Algorithms for controlling the movement of intelligent mobile robots based on fuzzy logic technology. Algorithms for planning the behavior of the robot based on the instructions of the operator. Experimental study of algorithms for control systems of intelligent mobile robots.

BRIEF DESCRIPTION OF THE COURSE
As a result of studying the discipline, the student should know:
- architecture and design methods of expert systems; models of knowledge presentation: speech logic, predicate logic; fuzzy logic, frames, semantic networks and production models;
- Uses methods of analysis and synthesis of natural language sentences based on syntactic and semantic-oriented approaches, features of logical programming in Prolog, basic models of neural networks.
- Develops and programms dialogues between computers and humans;
- designs and develops expert systems related to engineering tasks;
- solves problems of optimization by genetic algorithms;
- Works with instrumental software to create expert systems on the example of ESWin shell;
- Uses logical programming of programs that simulate neural networks in Prolog (PDC Prolog) and C ++.

**Elements and devices of automation (stands)**
CODE - AUT198
CREDIT - 5 (1/1/1)
PREREQUISITES - Theoretical bases of electrical engineering, metrology and measuring equipment

PURPOSE AND TASKS OF THE COURSE
The main purpose of teaching this discipline is to teach students to correctly choose the actuators in automation systems, to explain that the actuators are the most important element in automation systems, their correct calculation and selection determines the main quality indicators of the system.
The content of the discipline is based on the principle and theory of operation of actuators, the issues of correct and efficient selection and calculation of actuators of automation systems.
Here are the basic definitions and explanations related to the use of actuators in industrial automation.

**Elements and devices of robotics**
CODE - AUT199
CREDIT - 5 (1/1/1)
PREREQUISITES - Theoretical Foundations of Electrical Engineering, Elements and Devices of Automation

PURPOSE AND TASKS OF THE COURSE
The subject "Elements and Devices of Robotics" is aimed at teaching students the basics of the theory and practice of industrial electric drives and the main objectives are to develop students' skills in designing, calculating and modeling electric drives, to expand and strengthen knowledge of modern electric drives. .
The content includes the following topics: the basic concepts, definitions and study of disks for industrial electric drives, the characteristics and modes of operation of various electric drives; study of different versions of modern electric drives.

**Programming of microcontrollers**
CODE - AUT184
CREDIT - 5 (2/1/0)
PREREQUISITES - Algorithms and programming

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline "Programming of microcontrollers" is to form knowledge among students about the structure of microprocessor controllers, their classification and programming, methods of communication of controllers with computers and process equipment, technical means, on the basis of which modern automated control systems are used.
Objectives of teaching the discipline is to study the current state of microprocessor and microcontroller control systems; Gaining experience in software development for embedded control systems based on microprocessors and microcontrollers

BRIEF DESCRIPTION OF THE COURSE
Course Outline: a brief history of microcontrollers, family of microcontrollers, their registers. Tasks and role of microcontrollers, the basics of their standardization. Microcontrollers of the AVR family. AVR command system. Input / output devices in microprocessor systems. Programming of microprocessor systems. Promising microprocessor systems.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
As a result of studying the discipline, the student should know: Features of the internal structure of different families of microprocessors and microcontrollers; Element base and features of the use of specialized large integrated circuits and memory chips in systems based on microprocessors and microcontrollers. Must be able to: develop control modules using assembly language, using microcontrollers and programs for microprocessors and microcontrollers. Must master: skills of using cross-tools for software development of microprocessor systems and methods of creating a schematic diagram of the control device using a microcontroller.

**Programming of microcontrollers for robotic systems**
CODE - AUT183
CREDIT - 5 (2/1/0)
PREREQUISITES - Programming of microcontrollers

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline "Programming of microcontrollers for robotic systems" is to acquaint students with the basic concepts, construction methods, tools for the development of applied software solutions for the management of robotic systems.
Objectives of the discipline:

- to acquaint students with methods and instrumental environments;
- basics of programming of robotic systems;
- to teach students to effectively use analytical and numerical methods;
- offers methods and algorithms for solving robotics problems using programming languages and systems, computer mathematics systems, computer modeling tools;
- to teach students to use the learned methods of programming;
- develops robotic systems for solving theoretical and applied problems.

BRIEF DESCRIPTION OF THE COURSE
Course Outline: Classification of microcontrollers used in robotic systems, the structure of microcontrollers, the organization of microcontroller interruptions, training, external microcontroller devices, the study and research features of the programming environment of microcontroller systems.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
As a result of studying the discipline, the student learns the structure of different types of RTS; features of microcontrollers; Methods of developing RTS control schemes; must know the hardware interfaces.
Must be able to: Work in application software development environments for RTS: LabView, Robolab, NXT, NXC, QReal, Assembler; Connection of peripherals to microcontrollers; perform robot remote control; implementation of the terms of reference.

**Object-oriented programming**
CODE - CSE127
CREDIT - 5 (1/1/1)
PREREQUISITES - Computer modeling and programming

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching this subject is for students to master the models of creating software based on high-level languages, which will allow you to use the topics of data and the rules of working with them - object-oriented languages.

BRIEF DESCRIPTION OF THE COURSE
The object-oriented programming paradigm fundamentally defines the principles of creating scalable software using a high-level method of designing business environment concepts in a programming language. Today, there are many object-oriented and object-oriented programming languages, the most suitable for the academic course are languages such as Java and C #, on the basis of which a subject program is created. The principles of abstraction, encapsulation, inheritance, polymorphism are studied. The most commonly used software design models are being studied.
Particular attention is paid to the development of practical skills in software development. The course aims to solve many problems by writing program code using the OOP paradigm.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Upon completion of the course, students gain the necessary knowledge about the object-oriented approach to programming. Learns to identify the abstractions of business processes, the mechanisms of interaction of these abstractions. Learn to use inheritance, data encapsulation, polymorphism tools. You will learn to use effective techniques when writing program code using embedded design templates.

**Local government systems**
CODE - AUT187
CREDIT - 3 (1/1/0)
PREREQUISITES - Linear automatic control systems

PURPOSE AND TASKS OF THE COURSE
The purpose of the course is to train specialists who have mastered the theoretical apparatus underlying the theory of local government systems (LMS) and can perform computational work on the study and use of control systems based on modern computer technology.
Objectives of the course - the study of modern methods of analysis of UPS, the introduction of modern algorithms for the synthesis of UPS.

BRIEF DESCRIPTION OF THE COURSE
The training course includes sections of modern management theory related to the tasks of analysis and synthesis of RMS. Including: modern methods of LSG analysis; Implementation of algorithms for the synthesis of standard regulators of LSG on the basis of mathematical analysis, dynamic programming, modal control, methods of intelligent systems (genetic algorithm, ant colony optimization).

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Knowledge acquired during the course:
- Methods of automating the creation of mathematical models of RMS;
- Different structural and functional schemes of RMS;
- modern methods of analysis of LPG with the use of modern computer tools;
- modern methods of synthesis of LPG using modern computer tools;
- Modern Algorithms that ensure the operation of standard industrial controllers.
Skills and abilities acquired during the course (professional, managerial, communicative):
- Practical skills in the field of DZU;
- Mastering the theoretical foundations, basic principles and mathematical methods of drug research;
- Mastering the methods of automation of mathematical models of drugs;
- mastering modern methods of analysis and synthesis of drugs using modern computer tools.

**Typical regulators of automation systems**
CODE - AUT186
CREDIT - 3 (1/0/1)
PREREQUISITES - Mathematics, physics

PURPOSE AND TASKS OF THE COURSE
The main purpose of the course is to provide the future specialist with the necessary knowledge to study various principles of management; identification and comparison of static characteristics and transitions of open and closed control systems.
Typical controllers are usually used to control control objects, which can be divided into analog and discrete. Discrete controllers include pulse, relay and digital. Implements analog regulations, the names of which correspond to the names of standard references. For analog controllers, the input signal is the amount of adjustment error that is defined as the difference between the given and current values of the adjustable parameter (e = X - Y). The output signal is the magnitude of the control effect applied to the control object. Conversion of the input signal to the output is carried out in accordance with the laws of standard regulation.
The objectives of the course are to acquire the necessary knowledge for the effective use of modern automatic control systems in design. Gaining skills in creating and researching mathematical models. Mastering the sections of TAU necessary for solving research and applied problems.

BRIEF DESCRIPTION OF THE COURSE
The course "Typical regulators of automation systems" offers sections - standard references, standard laws of regulation, quality criteria of regulation, selection of the Law of regulation, methods of calculation of single-circuit ATS.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Studying this discipline allows the student to use the course "Typical controllers of automation systems" in solving applied problems in the synthesis of various control systems, to find sufficient tools for their study and to achieve quality results.

**Reliability of technical systems**
CODE - AUT405
CREDIT - 5 (2/0/1)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline is to study the methods of assessing the reliability of technical systems at the design stage, to study methods of assessing the reliability of technical systems in operation, to apply probability theory to predict and prevent equipment failures, to study existing equipment diagnostics.

BRIEF DESCRIPTION OF THE COURSE
The subject "Reliability of technical systems" includes the following main areas. Modern scientific ideas in the development of safety assessment of technical systems. Reliability theory of instruments, machines and structures. Reliability indicators, mathematical models of reliability and survival. Mathematical expectations of the number of failures and application of the theory of reliability and viability to the design conditions of machines and structures. Theory of endurance. Models of damage accumulation. Mechanics of fatigue disorders. Forecasting at the design stage. Control of breakdowns of machines and mechanisms. Maintenance planning. In accordance with the above, the teaching of the subject "Assessment of the reliability and viability of technical systems" is aimed at equipping future professionals with knowledge of the basic principles of the theory of reliability and viability of technical systems.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
After studying this discipline, the student must know and be able to apply the basic principles of the theory of reliability, evaluate the reliability of technical systems. The theory of reliability in any field is based on mathematics and technical disciplines. There are no reliable technical systems, so the student must competently demonstrate the man-made hazards included in the project submitted for technical examination and be competent to take measures to reduce damage in the event of industrial accidents, to assess their forecasting and prevention methods. Mastering the practical skills of assessing the reliability and man-made risk of technical systems under construction and modernization.

**Reliability of automation systems**
CODE - AUT404
CREDIT - 5 (2/0/1)
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline is to study the methods of assessing the reliability of automated systems at the design stage, the methods of assessing the reliability of operating systems, the application of probability theory to predict and prevent equipment failures, the study of existing equipment diagnostics.

BRIEF DESCRIPTION OF THE COURSE
The course considers the issues of determining the indicators of reliability, physical nature and causes of failures, their types and classification. Particular attention is paid to monitoring the performance of automated systems, troubleshooting and ensuring operational reliability. Methods for determining the technical condition of technical systems are given.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
After studying this discipline, the student must know and apply the basic principles of the theory of reliability, evaluate the reliability of automated systems.

- the student will know modern methods of assessing the reliability of automated systems;
- ways to ensure reliability at the stages of development, production and operation;
- basic concepts and quantitative indicators of reliability, factors influencing the reliability of electrical equipment;
- Mathematical models of reliability of the studied objects.

**Executive devices of automation systems**
CODE - AUT409
CREDIT - 5 (2/1/0)
PREREQUISITES - Theoretical foundations of electrical engineering

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline is to acquaint students with the physical principles of modern automation systems.
The objectives of the course are to teach students to correctly calculate and select the drives of automation systems, to understand that drives are a mandatory element of the control or regulation system, and the ability of the whole system to obtain the required quality indicators depends on their calculation and selection.

BRIEF DESCRIPTION OF THE COURSE
The content of the course considers the general problems of the theory of automation drives, describes the principles of classification of drives and their main characteristics, as well as issues related to drives as an element of the automation system.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Students should know:
- executive devices of automation systems and their classification, as well as the principle of operation and what are their devices;
- The main properties and characteristics of the actuators of automation;
must know:
- Selection of the right automation devices;
- optimization of working conditions in automation systems;
- identify and calculate the characteristics of the elements and devices of automation, as well as analyze the results of calculations.

**Microprocessor systems in control systems**
CODE - AUT422
CREDIT - 5 (2/1/0)
PREREQUISITES - Microelectronics

PURPOSE AND TASKS OF THE COURSE
Formation of knowledge of the bachelor on the principles of creating digital data processing tools, features of the organization of microprocessor devices and the use of microprocessors in technical facilities and process control systems, as well as skills in designing control systems based on microcontrollers and their application software

BRIEF DESCRIPTION OF THE COURSE
Particular attention is paid to the specifics of the use of the nomenclature of software and logic controllers produced by leading companies in the field of technical automation, which can create highly reliable systems for control and management of technological processes on the basis of this discipline. It provides for the study of organizational principles and the use of different classes of microprocessor systems, the development of skills in programming embedded systems. At the stages of system, structural and logical design, a special place is given to the design of hardware and software of microprocessor systems, methods of selection of microprocessor kits, features of development and configuration of hardware and software systems in cross-tools and resident mode. Microprocessor technology is widely used for control in industrial systems. The use of microprocessors in the management of distributed systems as a means of assembly and primary processing, transmission, conversion, as well as as a regulator of technological processes has expanded the functionality of sensors, drives, peripherals and terminal devices. This course covers issues that provide students with the knowledge and skills needed to solve industrial and scientific problems related to the choice of microprocessor tools for control systems.
KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Knowledge: in the field of architecture and programming of typical microprocessor systems; in the field of methods and tools for automatic modeling and design of microprocessor control systems; in the field of components for industrial automation systems and the nomenclature of controller families currently produced by suppliers.
Doing business: design of networks included in the objects of technological control and management, including on the basis of microprocessor control systems; reading and understanding of simple drawings of standard electronic equipment on the basis of digital integrated elements; Select the required elements according to the reference information in accordance with the operating conditions of the elements in the scheme.
Skills: work with tools and hardware for testing and configuration of microprocessor systems software in the implementation of ACS TP on their basis.
**Microcontrollers in robotics systems**
CODE - AUT189
CREDIT - 5 (2/1/0)
PREREQUISITES - Programming of microcontrollers for robotic systems

PURPOSE AND TASKS OF THE COURSE
The purpose of the discipline "Microcontrollers in robotics systems" is to teach the basic principles of robot control. Mastering the skills of control of various sensors and solving problems of microprocessor control.
Objectives of teaching the discipline is to study the basic principles of building information and measurement systems and control systems based on open microcontroller platforms, the formation of skills in the development of hardware and software for automated control and management systems of robots.

BRIEF DESCRIPTION OF THE COURSE
The educational process of the discipline is aimed at the formation of the following competencies: the ability to develop the necessary software for information processing and management in mechatronic and robotic systems, as well as for their design; ability to conduct experiments on existing models, models of mechatronic and robotic systems according to these methods and to process the results using modern information technology and technical means; Ability to conduct computational experiments using standard software packages to study mathematical models of mechatronic and robotic systems.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
As a result of studying the discipline, the student must know the basics of programming microcontrollers, algorithms for microprocessor devices, the use of libraries, as well as the creation of their own libraries.
Ability to program microcontrollers, connect various sensors and devices, as well as calculate the control algorithms of robots.

**Installation and adjustment of electrical control systems**
CODE - AUT140
CREDIT - 5 (1/1/1)
PREREQUISITES - Technological measurements and instruments

PURPOSE AND TASKS OF THE COURSE
The purpose of teaching the discipline is to provide students with the necessary amount of theoretical knowledge on the technology of installation, adjustment and safe operation of measuring and control devices, as well as students' installation of consumer electrical equipment, rules of technical operation, safety, construction standards and installation of electrical equipment. formation of a system of knowledge and skills on the principles of

BRIEF DESCRIPTION OF THE COURSE
Be able to analyze electrical and assembly drawings of industrial automation of discrete industries. Installation, adjustment and operation of industrial automation systems of discrete productions.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Must know the basic methods of installation of electrical equipment, adjustment of automation systems of devices, technical documentation during installation.
Be able to install panels, panels of control systems of electrical installations. Adjustment of control and management devices of electrical equipment.

**Installation and adjustment of robotic systems**
CODE - AUT172
CREDIT - 5 (2/0/1)
PREREQUISITES - Technological measurements and instruments

PURPOSE AND TASKS OF THE COURSE
To teach students modern methods of installation and repair of automation systems. Training of specialists with knowledge of new achievements in the field of installation, adjustment and operation of automatic control systems.

BRIEF DESCRIPTION OF THE COURSE
Students must have an understanding of the state standardization system, know and apply the features of the installation of automatic control systems, regulatory materials, troubleshooting methods.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Students must master and master the skills, analyze the reference and regulatory literature, perform standard calculations of structural elements, draw up technical documentation in accordance with a unified system of project documentation.

**Basics of creating MES-systems**
CODE - AUT400
CREDIT - 3 (1/1/0)
PREREQUISITES - Linear automatic control systems

PURPOSE AND TASKS OF THE COURSE

The course is designed for undergraduate students majoring in Automation and Robotics. The purpose of teaching the subject "Fundamentals of MES-systems" is the theoretical and practical training of students in the development and application of methods for creating MES-systems for specific industries.

BRIEF DESCRIPTION OF THE COURSE

The course "Fundamentals of MES-systems" contains the following sections: a set of systems for automation of the production environment; Information platform of MES-systems; determination of quality indicators of raw materials, semi-finished products and products of the enterprise; material balance information system of production; Automation system of enterprise laboratories; system of maintenance and repair of enterprise equipment; system of operational accounting and dispatching of electric power (electric resources; system of operative accounting and dispatching of electric power (CAD of heat resources); system of calendar planning and operational management of production work; administrative and organizational support of MES-systems.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

At the end of the course the student should know:

- Features of MES systems of enterprises of technological type;
- Composition of MES-system components;
- Functional structure of the information platform of MES-systems (collection and processing of primary data, storage of information, provision of information to users);
- Market for tools for the creation of MES-systems;
- assessment of current values of quality indicators of raw materials, semi-finished products and products of the enterprise;
- basic rules balance information, interactive process balance information;
- Purpose, classification, functions and market of IMS;
- The purpose, functions, composition and automation of the passport for repair work in the maintenance system;
- the impact of the environment on the efficiency of energy resources;
- activities, functions and composition of the system of operational management and planning of the enterprise;
- administrative management system of production.

**Automation of standard technological processes and productions**

CODE - AUT168

CREDIT - 5 (1/1/1)

PREREQUISIT - Microprocessor complexes in control systems

PURPOSE AND TASKS OF THE COURSE
Training of bachelors to independently solve theoretical and applied problems of automation of technological processes in various fields. Study of the principles and methods of automatic control of technological processes and the development of automated system control systems.

BRIEF DESCRIPTION OF THE COURSE
Modern level of automation of technological processes. The concept of automated control systems and the department of automated control systems, integrated and distributed automated control systems. Processing of technological information, conversion of technological information. Information on the types and forms of signals, the structure of technical means of automation and control of technological processes and complexes. Organization of communication of the control computer with the object of technological control. Object communication devices (DAC, ADC). Methods of analysis of the technological process as an object of management. Schemes of automation of typical technological processes. Real-time process control using a control computer. Basic information problems about the visual modeling system (Vissim) and optimal automated control algorithms.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
As a result of studying the discipline, students should know: the basics of the structure and architecture of process control systems, methods of applying theoretical rules in the design of technological processes.
Ability to choose the right technical means of automation, development and application of system models for process control.

**Design of automation and robotics systems**
CODE - AUT419-173
CREDIT - 5 (2/0/1)
PREREQUISITES - Robotic production technology

PURPOSE AND TASKS OF THE COURSE

Learning to use modern innovative design methods in real design, including unique systems of automated design: Autodesk Revit, Nemetschek (Allplan), Compas 3D, which allows you to comprehensively design control objects and automation systems. Objectives of teaching the discipline: the study of modern software and hardware for computer modeling of control objects and the development of automated design systems: ArchiCAD, Autodesk Revit, Nemetschek (Allplan), Compas 3D.

BRIEF DESCRIPTION OF THE COURSE

Technological process automation (TC) is one of the key factors in increasing productivity and improving working conditions. All existing and under construction industrial facilities will be equipped with automation equipment. For more complex industries (ferrous metallurgy, mechanical engineering, chemistry, production of mineral fertilizers, energy), complex automation of TC is provided. Production automation always begins with the development of appropriate design documentation, ie the design of automation systems. The course "Design of Automation Systems" (PSA) is designed to train future professionals in the design of modern automatic control and regulation systems TP, the development and training of the necessary design documentation. The PSA course is one of the final disciplines in the training of bachelors in TC automation in order to master the basic concepts, structure, classification, methodology of development (design) of automated systems using SCADA and modern information technology. It provides recommendations for the development of architecture, structure and technical documentation of automated control systems, software, information and technical support, as well as the design of algorithms for the control of technological facilities at the dispatching and field level of production automation.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

Education:

- Modern methods of assessing the structure and composition of ABBO;
- normative and technical documents (STD) on the stages and stages of creation of ABBO;
- stages and stages of design work and design documentation and their content;
- Development of modern software and hardware for computer modeling of control objects and automated design systems: ArchiCAD, Autodesk Revit, Nemetschek (Allplan), Compas 3D.

Skills and abilities (professional, managerial, communicative):

selection of technical means of IMS for optimal regulation of technological process parameters;

development of terms of reference, correct determination of the volume and composition of working documentation for the technological process;

- formulation of optimal management and control tasks;
- development of automation schemes, schematic diagrams of electrical, structural HVAC, external and pipeline wiring, equipment features;
- practical application of software and hardware for computer modeling of control objects and automated design systems ArchiCAD, Autodesk Revit, Nemetschek (Allplan), Compas 3D.

**Robotization of production processes**
CODE - AUT167
CREDIT - 5 (1/1/1)
PREREQUISITES - Fundamentals of Industrial Robotics

PURPOSE AND TASKS OF THE COURSE

The purpose of teaching the subject "Robotics of production processes" is to prepare bachelors to independently conduct theoretical, experimental, design and implementation work in the field of industrial robotics in various fields of industrial production. Getting acquainted with the purpose, device and operation of robots and robotic technological complexes used in various technological processes in mechanical engineering.

Objectives of teaching the discipline is to master the theoretical foundations and practical skills necessary for the development of robotic systems and complexes for robotization of technological operations and processes in various fields of engineering.

BRIEF DESCRIPTION OF THE COURSE

Course Outline: The content of the course includes extensive materials to describe the device, methods of development, the mechanism of operation of robotic systems and complexes in industry. A description of the construction and operation of robotic systems is provided: machining operations; forging pressing operations; Foundry operations; galvanic coating processes; welding operations; varnishing operations; assembly operations; transportation and storage systems in the field of mechanical engineering. Devices and processes of robotic technological complexes in the construction industry and metallurgy are considered.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

As a result of studying the discipline, the student should know: the structure of robotic systems and complexes for various purposes used in various industries and industries; work and content on the creation of robotic technological complexes in various industries. Must be able to: set and solve scientific and practical problems on robotics; development of robotics systems and complexes. Mastering the practical skills necessary for the development of robotic systems and complexes for robotization of technological operations and processes in various fields of engineering.

**SCADA-systems**
CODE - AUT402
CREDIT - 5 (2/1/0)
PREREQUISIT - Microprocessor complexes in control systems

PURPOSE AND TASKS OF THE COURSE

The purpose of the discipline is to study the principles of creating software and hardware), the choice of hardware, the principles of creation and selection of SCADA-systems in solving problems of automation of technological processes and production.

The objectives of teaching the discipline are the formation of a solid foundation of knowledge, high mathematical culture and practical skills, which is sufficient for successful production activities and allows him to independently acquire new necessary knowledge and achievements in the field of automated control systems.

BRIEF DESCRIPTION OF THE COURSE

Short course of discipline: ACS classification. Principles of structural organization of the EMS and ACS TP. Algorithmic, software, information, organizational and hardware support of the enterprise ACS. ACS Information-computing and management functions. ERP, MES and SCADA systems for managing the production activities of the enterprise. Data exchange based on DDE and OPC technologies. USO controllers and modules.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

As a result of studying the discipline, the student should know:

Gain an understanding of the automation of design work using software, as well as computer hardware, information collection and processing systems, general and industrial equipment.

Must know: Tasks of automation of technological processes and productions requiring the use of SCADA-systems; Methods of selection of SCADA-systems; Composition of hardware on which SCADA-systems can be installed.

Must be able to: determine the feasibility and feasibility of using new information technologies in their professional activities; development of the rationale and choice of automated tasks, studying the subject area, the most appropriate choice of hardware and software to solve this problem.

Practical skills: Design of distributed computer systems of technological control and control with the help of SCADA-systems.

**Basics of manipulation of robot control**

CODE - AUT401

CREDIT - 3 (1/1/0)

PREREQUISITES - Local government systems

PURPOSE AND TASKS OF THE COURSE

The main purpose of the course is to provide the future specialist with the necessary knowledge about the mathematical apparatus and methods of control of manipulative robots required for the study of robotics. Give a basic understanding of the kinematics and dynamics of manipulative robots, the use of homogeneous transformations to describe the kinematics, methods for solving direct and inverse problems of kinematics, different approaches to the synthesis of programmed control of manipulative robots.

Objectives of the course: to acquire the necessary knowledge for the effective use of methods for describing the kinematics for the development of programmed control algorithms for manipulative robots for research and practical problems in the professional field.

BRIEF DESCRIPTION OF THE COURSE

Manipulator as a mechanical system, methods of coordinate transformations, homogeneous coordinates and transformations, the position of the manipulator in the working space, forward and reverse position tasks, speed and acceleration of manipulator connections, kinematic control of the manipulator, forward and reverse speed calculations.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

Upon completion of the course the student should know:

- representation of the manipulator in the form of a kinematic chain;
- describe the kinematic chain of the manipulator on the homogeneous coordinates of the projection space;
- methods of solving direct and inverse problems in the position;
- Methods for synthesizing the programmed trajectory of the manipulation robot.

Be able to:

- analysis of the kinematic chain of the manipulation robot;
- solve a direct problem of kinematics for a given kinematic circuit of a manipulative robot;
- solve the inverse problem of kinematics for a given kinematic circuit of a manipulative robot;
- Synthesis of the trajectory of the manipulation of the robot control.

Practical skills:

- Analysis of the kinematic chain of the manipulation robot and the construction of homogeneous transformation matrices;

- On the construction of the matrix of the obtained homogeneous transformation and the solution of the direct problem of kinematics;

- on the practical application of methods for solving inverse problems for the synthesis of software trajectories on the degree of movement of the manipulative robot;

- On the development of laws for programmed control of manipulative robots.

**Industrial robots and manipulators**
CODE AUT188
Credit - 5 (1/1/1)
PREREQUISITES - Elements and devices of robotics

PURPOSE AND TASKS OF THE COURSE
The main purpose of the course is to provide the future specialist with the necessary knowledge about the mathematical apparatus and methods of control of manipulative robots required for the study of robotics. Give the basic concepts of disks used in industrial robots, analyzing the advantages and disadvantages of each of them. Consider the principle of operation of the pneumatic drive, the main units and design features, provide control circuits for the pneumatic drive of an industrial robot. Consider the principle of operation, the main units and design features of the hydraulic drive, give the control circuits of the hydraulic drive of an industrial robot. Consider the principle of operation of the electric drive, the main units and design features, provide control circuits for the electric drive of an industrial robot.
Objectives of the course: to gain the necessary knowledge for the effective use of disks for the development of programmed control algorithms for industrial robots for research and practical problems in the professional field.

BRIEF DESCRIPTION OF THE COURSE
Types of drives for industrial robots. Pneumatic drive of industrial robots. Industrial robot pneumatic control systems. Elements of pneumatic automation. Hydraulic drive of industrial robots. Hydraulic drive control systems for industrial robots. Electric drive of industrial robots. Electric drive control systems for industrial robots based on DC motors. Electric drive control system for industrial robots based on asynchronous motors.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
Upon completion of the course the student should know:
- types of drives used in industrial robots;
- design features, control schemes of pneumatic drives of industrial robots;
- design features, control circuits of hydraulic drives of industrial robots;
- design features, control circuits for drives with DC motors for industrial robots;
- design features, control schemes of drives with asynchronous motors of industrial robots.
Be able to:
- comparative analysis of the advantages and disadvantages of industrial robot drives;
- Analysis of the features of pneumatic drives used in industrial robots;
- Analysis of the features of hydraulic drives used in industrial robots;
- Analysis of the features of electric drives used in industrial robots.

Practical skills:
- to analyze the advantages and disadvantages of each drive used in industrial robots;
- on the use of a pneumatic drive for the degree of movement of an industrial robot;
- on the use of hydraulic drive as a degree of mobility of an industrial robot;
- On the use of electric drives as a degree of mobility of industrial robots.

**Telecommunication networks of industrial enterprises**
CODE - ELC440
CREDIT - 5 (2/0/1)
PREREQUISITES - Electronics, theoretical foundations of electronics

GOALS AND OBJECTIVES
Study of the main parameters and characteristics of telecommunications networks of industrial enterprises.

BRIEF DESCRIPTION OF THE COURSE
The subject "Telecommunication Networks of Industrial Enterprises" includes an in-depth study of the basic parameters and characteristics of the new generation of telecommunications networks, the basics of their structural construction, methods of design and integration of telecommunications networks and systems, taking into account modern trends in communications.

KNOWLEDGE, SKILLS, SKILLS UNTIL COMPLETING THE COURSE
As a result of studying the discipline the student:
- know the basic concepts and methods of creating a new generation of telecommunications networks;
- be able to calculate the parameters of telecommunications networks and systems;
- classification and design of communication systems and networks;
- have the skills of experimental research of telecommunications networks;
- evaluation and analysis of the obtained results;
- to apply the acquired knowledge in practice.

**Fiber-optic sensors and systems**
CODE - ELC428
CREDIT - 5 (2/1/0)
PREREQUISITES - Electrical Engineering, Electronics, Metrology and Measurement

PURPOSE AND TASKS OF THE COURSE
The main task of the discipline is to give students an idea of the principles, designs and parameters of modern optical-electronic and fiber-optic sensors for various purposes, the use of basic schemes and technical solutions, especially research and industrial technologies that determine the structure and functionality of modern sensors.

BRIEF DESCRIPTION OF THE COURSE
Basic parameters and characteristics of sensors. Active sensors. Passive sensors. Combined sensors. Influencing quantities. Error. Sensitivity. Linearity. Speed 2. Temperature sensors. Temperature scale. Measured and measured temperature. Metal resistance thermometers. Methods for plotting the characteristics of semiconductor thermistors. Connection diagrams. Thermistors. Thermocouples. Silicon resistance thermometers. Temperature measurement with diodes and transistors. Temperature measurement by thermal noise. Quartz thermometers. Examples of electrical circuits of temperature sensors. Contactless temperature sensors. Principles of construction. Structural and electrical diagrams of contactless thermometers. Influence of the object's radiation coefficient on the measurement accuracy. 3. Optical-electronic sensors. Parameters and characteristics of optical sensors. Schemes of connection of photoresistor and photodiode optical sensors with the use of integrated circuits. Circuit diagrams for phototransistors, field phototransistors. Dynamic power supply mode of the avalanche photodiode. Four quadrant photodetector. Position sensitive detectors. Heat receivers of radiation. Radiation detectors based on thermocouples. Pyroelectric radiation detectors. Motion detectors based on passive IR elements. Bolometer. Methods for improving the accuracy of infrared sensors. Optoelectronic pressure sensor. Optical hygrometer. Lighting sensors. Optical sensor for control of latitudinal pulse load. IR sensor for spatial orientation. Pyrometric sensor of gas concentration in combustion products. Recirculation sensor of gas concentration in two-wave laser. 4. Fiber-optic sensors. Classification. Water with optical fiber as a transmission line. Sensors based on fluorescence-based light intensity measurement. Chemical concentration sensors. Oxygen saturation sensor. Light polarization sensors. Doppler vibration, flow sensors. Fibrous water as a sensitive element. Interference sensors. Fiber-optic microphone. Changes and additions were made on the basis of sensors. Radioactive radiation sensor. Use of fiber-optic sensors in biomedical equipment.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

As a result of studying the discipline, the student should know: the main trends and directions of development of optical-electronic and fiber-optic sensors for various purposes; - Fundamental laws of optics, properties and characteristics of light fields, basic laws and models of light propagation; 5 methods and principles of optical measurements and research; certain types of optical-electronic and fiber-optic sensors, features of their design, conditions and methods of their use; be able to: - formulate requirements for promising optical-electronic sensors and components. - the use of methods of optical measurements and research, technical means and methods of processing the results obtained; - the use of general rules and methods of adjustment, adjustment and operation of optical-electronic and fiber-optic transmitters to solve various problems. must know: - methods of interpretation of measurement information in relation to the defined parameters of the sensors.

**Defense of the thesis (project)**
CODE - ECA103
CREDIT - 6
PREREQUISITES - no

PURPOSE AND TASKS OF THE COURSE
Thesis design (completion of the thesis) is the final stage of training students in higher education and has a purpose:
- systematization, consolidation and expansion of theoretical and practical knowledge in the field of development of technological processes and production automation systems for design, application of this knowledge in solving specific scientific, theoretical, economic and production problems arising in the creation of appropriate automation systems;
- development and mastering of skills of independent work
research and experimental methods for solving various problems and issues of ACS, developed in the diploma project;
- to determine the readiness of students for independent work in the conditions of modern industrial, scientific, technical and cultural progress.

BRIEF DESCRIPTION OF THE COURSE
In the diploma project the student designs a specific automation system, creating the structure of problems to be solved, their mathematical concepts, engineering calculations of automation and control systems, the choice of technical means of automation, graphical section in the form of structural, functional and schematic automation schemes.
In the dissertation of a research nature, the student conducts research on the development of automation systems by modeling objects and setting a mandatory mathematical problem, developing or selecting algorithms for solving it and experimentally testing the proposed solutions on a computer or object. The dissertation can be theoretical or practical. At the discretion of the supervisor of the thesis in the first case it is allowed to reduce the computational-graphical part, replacing some drawings with posters depicting theoretical calculations; in the second case, a part of the drawings with graphs, diagrams, tables, etc., which reveal the content of the obtained experimental results can be replaced

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE
The diploma project (work) is a graduation work, on the basis of which the state certification commission decides on the issue of awarding a bachelor's degree in "Automation and Control" to a student.

## Content