Ministry of Education and Science of the Republic of Kazakhstan
Non-commercial Joint Stock Company "Holding "Kasipkor"

EDUCATIONAL PROGRAM

SPECIALTY: 1302000 – AUTOMATION AND CONTROL (on a profile)

Qualification: Instrumentations and automatic equipment mechanic
Electrician
Industrial processes automation Junior engineer

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"Kasipkor" Holding Non-commercial Joint Stock Company

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- ALE "Kazakhstan Association of Energy ouditors "
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SUBMITTED

"Kasipkor" Holding Non-commercial Joint Stock Company

CONSIDERED, APPROVED AND RECOMMENDED

At a meeting of the Republican educational-methodical Council for Technical and Vocational Education of the MES RK, Protocol No_4_ dated "_21_"_12__ 2016 year

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1. **Explanatory Note to the educational program**

This educational program is based on modular competence-based approach in accordance with international modern requirements for mid-level professionals and skilled workers, with the participation of foreign partner Dudleycollege (UK).

International experience, structure and content of training programs and training of technical and service staff that are used in several European countries:

- focused on the acquisition of a number of competencies in the curriculum and educational programs on a specialty;
- in the structure and content differ from the traditional subject - cyclic approach to the description of the content of technical and special disciplines and types of training and production work;
- disciplines of general professional and professional training are combined into several modules aimed at the qualification competences;
- requires the development of training modules, aimed at the performance of certain types of qualification competences of future professional activity.

The developers of this educational program have considered the above features of the educational programs of the European countries, the international concept of learning throughout whole life, as the content of educational programs aimed at the formation of professional competence of future professionals capable of adapting to changing situations at work, on the one hand, and going on professional development and education - on the other hand.

Also there have been considered the general requirements of the State Compulsory Educational Standard (hereinafter the "CES") for Technical and Vocational Education, and applied to it the structure of the model curricula and requirements for knowledge, skills and competencies by level of qualifications established in professional standards.

Main provisions of the following was used when designing the educational program:

a) international conceptual documents on classification of educational programs and the corresponding qualifications:

- 2001 Recommendation concerning Technical and vocational education and training in the twenty-first century.
- UNESCO's 2011 International Standard Classification of Education (ISCED)
- ISCED Fields of Education and Training 2013
- European Qualifications Framework (EQF)

b) Laws and national programmes of the Republic of Kazakhstan and normative documents in the field of education:

- The Law of the Republic of Kazakhstan *On Education,* 2007;
- State Programme for the education development in the Republic of Kazakhstan for 2011-2020;
- State Programme on industrial-innovative development of the Republic of Kazakhstan for 2015-2019;
- National Classifier of professions and specialties in technical and vocational, post-secondary education of the Republic Kazakhstan the NC RK 05-2008, appr.;
- National Qualifications Framework of the Republic of Kazakhstan (joint Order from the Minister of Labour and Social Protection of Population of the Re-

public of Kazakhstan of September 24, 2012 no. 373-o-m and from the Minister of Education and Science of the Republic of Kazakhstan of September 28, 2012 no. 444);

- RK Mandatory State Standard of technical and vocational education approved by Governmental Decree of the Republic of Kazakhstan of August 23, 2012, no. 1080.
- Model rules for the conduct of ongoing monitoring of school performance, intermediate and final assessment of students, approved by Order from the Minister of Education and Science of the Republic of Kazakhstan of March 18, 2008 no. 125.
- Methodologies in the development of model curricula and educational curricula, integrated educational programmes on specialties in technical and vocational education, approved by Order from the Minister of Education and Science of the Republic of Kazakhstan of 09.05. 2016 no. 446
- The Development Strategy of Holding Kasipkor NC JSC for 2012-2021 (Decree of the Government of the Republic of Kazakhstan of December 31, 2011, no. 1751).

In the development of this educational program based on the modular competency approach and the need for the introduction of modular training on preparation of cadres of skilled workers and mid-level professionals following key definitions are used:

Modular training program is a part of the educational program, aimed at the development of knowledge, skills and competencies required to perform certain professional activities within the same specialty;

Module is an independent, self-sufficient and complete profile of the educational program or training period;

Working curriculum is a document developed by the organization of technical and vocational education for a particular discipline, internships / practices, and other learning activities (modules) of the working curriculum on the basis of a model curriculum;

Modular unit is a logically acceptable division of labor in a particular profession, having a clear beginning and end of work, which can be divided further which result is a product, a service or part of the work (working operation). This is the definition of the ILO (International Labour Organization);

Training module (modular training unit) is a set of sections (subjects) of learning content within a single training module (discipline), which provides the knowledge and performance of specific skills of the future qualifications;

Qualification is a level of training for the competent implementation of certain activities in specialty received;

Plan of training process (curriculum) is a document regulating the list, sequence, amount (workload) of disciplines (modules), internships / practices, and other types of educational activity of students of the appropriate level of education and forms of control;

The educational program of specialty: 1302000 - Automation and Control is developed to prepare a new generation of skilled workers in the field of automation of manufacturing processes for industries of metallurgy and energy power of Kazakhstan and on the basis of consultation and analysis of the needs of enterprises and companies operating in the country.

The educational program is developed taking into account requirements to competences of levels of qualifications 3, 4 and 5 that belong to the National frames of

qualifications of the Republic of Kazakhstan (further – NFQ) for training of specialists:

130201 2 – Control-measuring and automatic equipment technician (3rd level of NFQ);

130202 3 – Electrician (4th level of NFQ);

******** – Technological processes' automation Junior engineer (5th level of NFQ).

The educational program includes workers' training according to the profession with the issuance of certificate of skills and middle management training with the issuance of a college degree, as well as training of junior engineer of process automation with a diploma.

on the basis of basic secondary education	on the basis of General secondary education
• 3 th level: 2 year 10 months; • 4 th level: 3 year 10 months; • 5 th level: 4 year 10 months.	• 3 th level: 1 year 10 months; • 4 th level: 2 year 10 months; • 5 th level: 3 year 10 months.

The student who was successful to achieve level 3 of NFQ - "Control-measuring and automatic equipment technician" is able to work. If the student wishes to continue his education within the specialty, he will be studying for a further 10 months to reach the 4th level - "Electrician". Next, the student can continue education for a further 10 months to reach a higher level - "Technological processes' automation Junior engineer".

The structure of the educational program of the specialty contains a list of modules in cycles: compulsory modules; basic general professional modules; professional modules; defined by the educational organization modules and professional practice module.

The educational program based on competencies, designed in line with the concept of learning throughout life, as the content of educational programs aimed at the formation of highly qualified specialists, capable of adapting to changing situations in labor sphere on the one hand and to continue professional development and education on another hand.

This approach of teaching allows you to create a feeling of success in each student, which is created by the organization of educational process in which the student has the opportunity to manage its own learning, which teaches him to take responsibility for its own learning, and in the future - for its own professional growth and career. Thus, the student, as a consumer, being satisfied with the receiving education, he can improve it throughout its life, in response to changes in the labor market.

General characteristics of the profession

Instrumentations and automatic equipment mechanic – is a worker, repair, installation, adjustment, instrumentation and automation specialist. CMAE technicians work at enterprises of the different industrial sectors.

CMAE technician responsibilities include:

- Supervisory of the work of control-measuring equipment and and automation facilities;

- Detection of defects in the devices;
- Carrying out repair, installation, regulation, setup, adjustment, test of automatic equipment, apparatus, systems, assemblies, etc.

Thus, the main objective of CMAE technician - provision of repair, installation, adjustment, regulation of the automatic control systems of technological equipment.

The main object of work - equipment (repair, adjustment of devices), accompanying - sign systems (numbers, drawings, symbols).

In its work, the CMAE technician uses material work equipment - handy (hand tools - a hammer, screwdriver, pliers, file, spanners, etc.), measuring instruments and devices (ammeters, dosimeters, etc.). In addition, his main intangible (functional) tools - analytical, technical thinking, spatial imagination, good concentration, memory; coordination of movements of the whole body, especially the hand-motor skills, speech as well as senses - sight, hearing, touch, smell.

CMAE technician job has quite clear and established by:
- rules, instructions;
- manuals;
- rules of technical exploitation of the devices, power tools and equipment;
- the internal conduct rules and labor protection norms.

The nature of the CMAE technician job has its specific organisation, so he can independently carry out all work assignments from the beginning to the end, and collectively, when repairs and adjustments of the equipment involve the team of experts.

Functionally the CMAE technician is an executor, but all activities and workload he plans and distributes independently (at individual fulfillment).

Related qualifications
- Apparatus operator, automated control system (ACS) operator.

Electrician - provides proper condition, trouble-free and reliable operation of serviced devices and equipment, their correct operation, the timely high-quality repair and modernization in accordance with technical maintenance instructions, approved by drawings and diagrams, specifications and standards.

Learns conditions of the devices, identifies causes of premature wear, takes measures to prevent and elimination.

It instructs the workers using these devices on rules of operation and measures to prevent production injury.

It supervises the work of electricians, controls quality of the performed work, technology compliance, rules for technology safety, occupational health, industrial hygiene and fire security.

Takes part in the elimination of malfunction devices, their repair, installation and adjustment.

Take action to provide jobs with materials, raw materials, spare parts, measuring instruments, protective equipment, tools and devices, technical documentation.

Practices and introduces progressive methods of technical maintenance, repair, installation and other work on the enhancement type of devices. Participates in the preparation of applications for the materials, spare parts,instrument and provides them with economical and rational expenditure.

It takes part in the investigation of the causes of damage of the equipment and the

development of measures to prevent accidents and occupational injuries.

Qualifications for **Industrial processes automation Junior engineer** is actually needed in the labor market. Modern higher education of the RK prepares bachelors - specialists of academic orientation. Developed educational program provides training in applied orientation of receiving practical experience in the industry during the process of learning in organizations of technical and professional, post-secondary education.

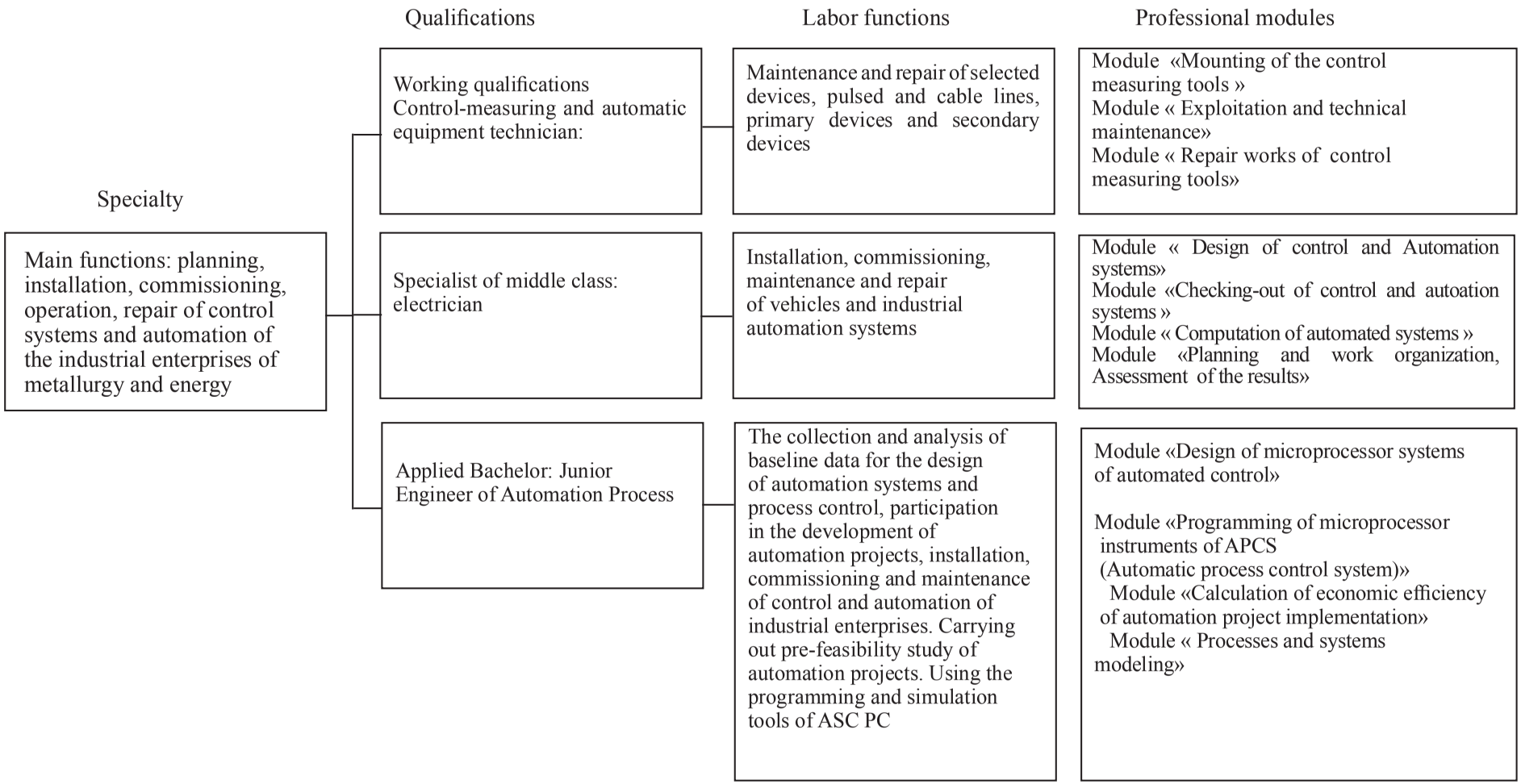
Development of the educational program is justified in the interest in qualified engineers for automation with practical orientation by many companies and enterprises, including metallurgy and energy.

Junior engineer must know the technology of production enterprise, the requirements of development and patent research. He prepares and draws up the technical documentation on the basis of this knowledge. For implementation in the production of new means of automation and mechanization, there required knowledge of their economic efficiency.

2 List of abbreviations and designations

1. CM – compulsory modules
2. GEM– general educational modules;
3. GHM– general humanitarian modules;
4. SEM– social-economic modules;
5. BGPM – basic general professional modules;
6. PM – professional modules;
7. MEO – modules defined by the educational organisation;
8. PL – professional learning;
9. PP – professional practice;
10. IC – intermediate certification;
11. ALPTQ – assessment of the level of professional training and qualification;
12. FC – final certification;
13. DP – diploma project;
14. EP – engineer project;
15. C – consultations;
16. EA – extracurricular activities;
17. ST– state standard;
18. ACS TP – automated control system of technological process;
19. ARS– automatic regulation system;
20. MT – measurement tool
21. CMAE – control-measuring and automatic equipment technician

3 Functional analysis



4 Requirements to the students' levels of preparation

Competences	**Industry / enterprise requirements for the training of students**			
Basic competences	***Industrial processes automation Junior engineer***	***Electrician***	***Instrumentations and automatic equipment mechanic***	BC 1 To understand the nature and the social importance of their future profession, to present a sustainable interest to it. BC 2 Systemically acting in a professional situation, analyze and design their activities, make their own decisions in the face of uncertainty; BC 3 Demonstrate responsibility for their work, independently and effectively solve the problems in the field of professional activity; BC 4 Practically solve the problems in the organization of professional activities on the basis of the rule of law; own professional vocabulary; BC 5 Research to organize the work, to apply computer technology in the field of professional activity; BC 6 Positively cooperate and partner with colleaques. BC 7 To raise the professional level, to acquire new knowledge; BC 8 Persistently strive for self-improvement, to creative self-realization; BC 9 Use rational working methods and ways of work organization in the workplace; BC 10 Economical use of materials, carefully handle the equipment and tools.
			BC 11 Know and apply the laws and regulations of the Republic of Kazakhstan; BC 12 Use computer technology as the information management tool	

Professional competences	***Industrial processes automation Junior engineer***	***Electrician***	***Instrumentations and automatic equipment mechanic***	PC2.1 carry out independent work in typical situations and under the guidance in difficult Barrier-professional activity: perform a solder by variety of solders (copper, silver, etc.); - To carry out the heat treatment of parts with subsequent fine-tuning them; - Use tool for the production of plumbing and installation work; - Use of measuring devices and exemplary, small-scale mechanization tools and equipment; - To determine the defects of repaired devices and eliminate them; - To carry out repair of average complexity of devices under the supervision of a technician of higher qualifications. PC 2.2. To solve typical practical problems; choose the method of action from the known on the basis of knowledge and practical experience. - compose schemes of automatization of average complexity - compose defect reports and fill the passports and certificates for the devices and equipment. - implement information technologies to solve professional tasks.
				PC 3.1 Compose the completion, repair, adjustment, regulations, and presenting tools, measurements and automatic control of average complexity, tools of technological protection of signalization, blocking, and remote control. Choose main and other materials for completing the works, complete the control of quality of repair works; PC3.2 Own the basics of technical regulation and wage organization in enterprises sector, perform typical calculations of the basic technical and economic performance of the production unit; PC3.3 Apply the method of calculation of regulatory authorities, narrowing devices, the metrological characteristics of the instrument, the standard settings of regulators; PC 3.4 Carry performing management activities for the implementation of automation systems under the direction of providing for independent determination of problems, organization and control of the activities of subordinate employees: - organize the work at the manufacture in accordance with the technological regulations, to provide reliable, safe and efficient operation of electrical equipment in the production areas; - read and execute the technical documentation for installation, setup, adjustment, repair, technical service, operation of automatic control systems, control devices of regulation and protection systems; - exploit the system of automation of technological processes on the profile of the enterprise, identify the causes of malfunctions and accidents, to eliminate them, to control the quality of work performed.
		PC 4.1 Participate in the development of enterprise management systems, microprocessor-based projects of metallurgy and energy, automation of technological processes; PC 4.2 Use the application software in the design, implementation, commissioning and operation of microprocessor-based process control systems of metallurgy and energy; PC 4.3 Conduct a feasibility study for automation projects, to evaluate the efficiency of the production unit; PC 4.4 Use the methods of computer modeling and management of maintenance and operation of microprocessor control systems.		

5. Structure of the educational program

Professional competences	Study module	Results of studies	Code of formulated basic competence
Qualification «Control-measuring and automatic equipment technician»			
PC2.1 To carry out independent work in typical situations and under the guidance in difficult situations of professional activity: - to carry out a solder by variety of solders (copper, silver, etc.); - to carry out the heat treatment of parts with subsequent fine-tuning them; - use the tool for the production of plumbing and installation work; - to use of measuring and exemplary devices , small-scale mechanization tools and equipment; - to determine the defects of repaired devices and eliminate them; - to carry out repair of average complexity of devices under the supervision of a technician of higher qualifications.	BGPM01-«Selection and usage of electrical engineering materials, tools and equipment» PM 01 - «Mounting of the control measuring tools» PM 03 - «Repair works of control measuring tools»	To know: the structure and classification of electrical materials; building electrical materials and their electrical, magnetic, thermal, mechanical, and physical and chemical characteristics; the purpose and scope of the wires, tires, cables. To be able to: perform a simple repair of devices using knowledge of electrical materials; To have an idea of the organization of repair work and the workplace equipment of technicians; draw up technical documentation for equipment repairs; to perform certain types of repair work on the instruments and means of automation.	BC 1 BC 2 BC 3 BC 6 BC 7 BC 10

PC2.2 Solve typical practical tasks; choose the mode of action of the known on the basis of knowledge and experience: - draw up schemes of automation of medium difficulty; - draw up lists of deficiencies and fill the passports and certificates on the devices and machines; -apply information technology to solve professional problems.	BGPM 02 - «Perusal and development of typical schemes of automation» BGPM 03 - «Occupational health and safety compliance » PM 02 - «Exploitation and technical maintenance»	Know the classification of automation schemes to destination, type of supply; current standards at the designation of functional circuits of automation components and schematic diagrams. Compose shareware graphics and lettering schemes of functional elements of automation and electrical schematic diagrams. Know and apply information and communication technologies in the preparation of automation schemes. Understand the basic laws and regulations on health and safety. Know how to identify and control hazardous situations in the workplace. To be able to carry out a risk assessment, establishing control measures. To understand the methods used in the registration and reporting of accidents and incidents. Have an idea about the organization and equipment of metrology laboratory.To have an idea of the order of verification, calibration and certification of equipment and automation systems. To be able to perform operations and maintenance of devices and automation.	BC 1 BC 2 BC 3 BC 4 BC 5 BC 6 BC 7 BC 8 BC 9 BC 10

Qualification «Electrician»			
PC3.1 To carry out repairs, completing, testing, control, adjustment, alignment, installation and commissioning of controls, measurement and automatic control of average complexity, technological protection tools, signalization, lock and remote control to select the main and auxiliary materials for the implementation of works to control the quality of repair and installation works;	PM 01 - «Mounting of the control measuring tools» PM 05 - «Checking-out of control and automation systems»	Know: the general principles of the organization of installation works of automated systems; composition and content of the project documentation for the installation of automaticized systems. Know the composition of works on installation of pipe and electrical wiring systems of automation, instrumentation and automation. Know the methodology of pre-installation testing of instruments. Know what is included in the scope of independent set-up, procedure and content of work on the second phase of adjustment control and automatic regulation, scope of work of the third stage of commissioning.	BC 2 BC 3 BC 4 BC 5 BC 6 BC 7 BC 8 BC 9 BC 10
PC3.2 Own the basics of technical regulation and wage organization in enterprises sector, perform typical calculations of the basic technical and economic performance of the production unit;	PM 07 - «Planning and work organization, assessment of the results»	Know the basic principles of the production structure of the enterprise Be able to make a schedule for repair, maintenance, installation. Be able to calculate the rate of time and service. Know the method of calculating remuneration for different forms and systems. To be able to distribute the payroll team with coefficient of labor participation.	BC 2 BC 5 BC 9 BC 11 BC 12

PC3.3 Apply the method of calculation of regulatory authorities, narrowing devices, the metrological characteristics of the instrument, the standard settings of regulators;	PM 06 - «Computation of automated systems»	Know the basics of automatic control theory, bases of construction, calculation and analysis of automatic control systems. Know the basics of metrology and measurement techniques of electrical and non-electrical quantities; methods of analysis of measurement results. Know the main types of devices and operating principles of measurement systems. To be able to complete instruments for measuring technological parameters, to know the ways of pairing devices in equipment and methods of calculation circuits. Understand the purpose of automation tools used in the construction of automatic control systems, to know the types and range of manufactured products produced by industrial automation tools.	BC 4 BC 5 BC 6 BC 7 BC 12

PC 3.4 Carry the performing-management activities for the implementation of ASC TP under the direction that is providing independent determination of problems, organization and control of the activities of subordinate employees: - To organize the work at the facility in accordance with the technological regulations, to provide reliable, safe and efficient operation of electrical equipment in the production areas; - Read and execute the technical documentation for installation, setup, adjustment, repair, maintenance, operation of automatic control systems, control devices control and protection systems; - To exploit the system of automation of technological processes on the profile of the enterprise, identify the causes of malfunctions and accidents, to eliminate them, to control the quality of work performed.	PM 02 - «Exploitation and technical maintenance» PM 04 - «Design of control and automation systems»	Have an idea about the organization and equipment of metrological laboratory. To have an idea of the order of verification, calibration and certification of equipment and automation systems. To be able to perform operations and maintenance of devices and automation. Know the processes of metallurgy and energy to be controlled, the requirements for the control and regulation of their basic technological parameters. Know how to obtain reliable information about the process parameters, methods and tools of measurement methods for processing the information received. Know the applicability,the principles of operation and technical characteristics of devices and automation, electrical, pneumatic and hydraulic actuators included in the control system. Know the methods of forming the control and regulation circuits, choose instruments and automation control system. To be able to use standard documentation and international standards in the development and design of project documentation used in the implementation of automation systems. Use of computers and computer-aided design in the development and design of project documentation of control systems.	BC 2 BC 3 BC 4 BC 6 BC 7 BC 8 BC 9 BC 11 BC 12

Qualification «Junior Engineer of technological process automation»			
PC 4.1 Participate in the development of microprocessor-based systems of control of enterprises of metallurgy and energy projects, automation of technological process	PM 08 - «Design of microprocessor systems of automated control»	Knows the architecture of distributed control systems, methods of organization. Understands information transmission and processing in the control system, knows the software, technical communication between the system elements, their characteristics. Knows the applicability, the principles of the organization and the technical characteristics of the PLC and other elements of a microprocessor control system. Knows the stages of development, packaging design and project documentation used for the construction, installation, maintenance and operation of the distributed process control systems.	BC 1-BC 12
PC 4.2 Use the application software in the designing, implementation, commissioning and operation of microprocessor-based process control systems,\ of metallurgy and energy	PM 09 - «Programming of microprocessor instruments of APCS (Automatic process control system)»	Knows the types of microprocessor tools, their structure and use in control systems. Understands the logical structure of microprocessor-based ASC TP, the need for software for its operation. Knows the use of SCADA-systems in the dispatching process control. Applies a platform-independent programming languages controllers for various PLC types.	BC1-BC 12

PC 4.3 Conduct a feasibility study for automation projects, to evaluate the efficiency of the production unit..	PM 10 - «Calculation of economic efficiency of automation project implementation»	Knows the content and direction of the investment policy of the enterprise. Knows the factors affecting the efficiency of investment, the sources of their funding. Able to carry out a feasibility study for projects of automation of technological processes.	BC 1-BC 12
PC 4.4 Use the methods of computer modeling and control in serving and exploitation of the of microprocessor control systems.	PM 11 - «Processes and systems modeling»	Know the methods for mathematical description of objects of regulation. Understand the essence of the analysis and synthesis of linear control systems with feedback control systems parametric synthesis techniques. Know the methods for assessing the quality of the regulatory process and the stability of linear automatic control systems. Know the computer modeling program for calculations and studies of processes and systems. Apply in practice the methods of computer simulation in the development of control systems.	BC1-BC 12

6 Content of the educational program (modules)

BGPM.01 «Selection and usage of electrical engineering materials, tools and equipmen»

Aims and objectives:

This module will give to students the opportunity to gain knowledge of electrical materials, their properties and use.

Introduction to the module

This module will give students an understanding of the structures, properties and classification of electrical materials used in the automation of production processes and allow them to choose the materials for the different types of work.

The module is suitable to students engaged in the installation, operation and maintenance of instruments and automation equipment, particularly where materials are delivered in the form of stocks, to be used in the production process. The module covers a range of materials, some of which students may be unfamiliar initially.

This module will enable students to identify and describe the structure of electrical materials and their electrical, magnetic, thermal, mechanical, physical and chemical characteristics; to be aware of applications and methods for producing electrical materials and classify them according to their properties.

Students will apply their understanding of the physical and mechanical properties of the conductive materials and dielectrics, design requirements, expenses and availability to accurately set the material for a given application.

All materials have limits beyond which they can not meet the requirements that are imposed on them. Common failure modes will be shown and described, it will enable students to recognize in the future, where informed choices can play a decisive role in the choice between success and failure of the product.

In the course of industrial training there provided owning the skills of working with tools, repair work according to the instructions and regulations.

Industrial training and professional practice – educational fitter and mechanical practice (36 h.), electrical and fitter practice (36 h.)

Results of the studies

After completing this module students have to:

1. Know the structure and classification of electrical materials.
2. Know the structure of electrical materials and their electrical, magnetic, thermal, mechanical and physico-chemical characteristics.
3. Know the purpose and scope of the wires, tires, cables.
4. To be able to perform simple repairs of devices using the knowledge of electric materials.

Content of the module

1. Know the structure and classification of electrical materials.

Metal structure: molecular lattice; granulation; crystals; crystal growth; fusion,

for example, embedded in an atom, replaced; state of diagram, for example, eutectic, the solid solution, the compound; intermetallic compound.The structure of the plastics monomers; polymers; polymer chains, such as linear, branched, cross-linked; crystallinity; the glass transition temperature.

Ceramic Structure: amorphous; crystal; connected.

Composite structure: dispersion; fiber; layers.

Crystallization of metals: ferrous, for example, carbon steel, cast iron (gray, white, malleable, ductile iron), stainless steel and heat-resistant steel (austenitic, martensitic, ferritic); nonferrous metals such as aluminum, copper, gold, lead, silver, titanium, zinc; no iron alloys, for example, thermally treated copper with aluminum - malleable and lithium is not thermally treated - malleable and lithium, copper-zinc (brass), copper-tin (bronze) alloy of nickel and titanium, thermocouple alloys (Chromel-Copel, chromel-alumel, platinum, platinum).

Classification of nonmetals (synthetic) thermoplastic polymeric materials such as acrylic, polyethylene, polyvinyl chloride (PVC), nylon, polystyrene; curable polymers, such as phenol formaldehyde, elastomers; ceramics such as glass, porcelain; composites such as layers, fibrous fixed (carbon fiber, reinforced plastic glass (RPG), cement, dispersion reinforced, particulate; the crystals.Classification of nonmetals (natural): for example, wood, rubber and diamond.

2. Know the structure of electrical materials and their electrical, magnetic, thermal, mechanical and physico-chemical characteristics.

Structure and properties of metals; conductivity; resistivity; permeability; the dielectric constant; rigidity; strength; ductility; plastic; elasticity; brittleness. Physical properties: density; melting temperature.

Alloys of iron and carbon; non-ferrous metals and their alloys; magnetic materials; electrical-magnetic materials, conductive materials; classification of conductive materials; wires, tires, cables; semiconductor materials: properties, application areas; insulating materials; physics of dielectrics; physico-mechanical characteristics; gaseous dielectrics; polarizing material; compounds; rubber; insulating mica, ceramics, glass; layered plastic.

3. Know the purpose and scope of the wires, tires, cables..

Purpose and application in control and automation systems, thermocouple, installation wires. Copper and aluminum wires, wires made of special alloys (Chromel-Copel, Chromel-alumel, thermocouple alloy). Stamps of thermocouple and installation wires.

Control, power, installation cables, control cables, their characteristics and applications in the automation of industry and energy systems; protective covers and special coatings, depending on the operating conditions.

Select the quantity and the line cross section. Stamps of wires and cables produced by industry. Purpose of tire, materials, application in industry.

4. To be able to perform simple repair devices using the knowledge of electrical materials.

Fitting-machining materials using with use of measuring tools - rulers, calipers, level rezbomerom, templates and probes.

Cutting metal hacksaw; cutting of metal in a vice, on a plate or anvil; straightening and bending pipes on benders; hole drilling and chamfering, threading.

Permanent connection of pipes - welding and brazing, used materials, tools, fixtures and equipment.

Split threaded and flanged connections. The cushioning material, their choice of the parameters and properties of technological environments.

Possession of skills to work with tools and devices.

Tinning the wires, soldering the electrical connections; cutting, connection, tap and terminating wires.

Possession of method of repair works on the instructions and regulations.

Repair of the primary temperature transmitters; repair of pressure and vacuum devices.

Safety in the performance of fitting-mechanical and repair work.

Learning outcomes and assessment criteria

Results of studies of student after successful completion of this module	**Criteria of marking Student has to**
LO1 knows the structure and classification of electrical materials	1.1 Be able to select electrical equipment for their intended purpose 1.2 To be able to classify the conductive material 1.3 To select data insulators for practical work;
LO 2 Knows the structure of electrical materials and their electrical, magnetic, thermal, mechanical and physico-chemical characteristics	2.1 Choose the electrical material in accordance with production requirements.
LO 3 Knows the purpose and scope of the wires, tires, cables	3.1 Be able to decipher the wires of brand and cables; 3.2 Select brand wires and cables based on installation conditions 3.3 Choose the cross section of wires and cables for maximum current load
LO 4 Able to perform simple repairs of devices using the knowledge of electronic materials.	1.1 Owns the skills with tools and devices. 1.2 Identifies the cause of the fault of repaired instruments. 1.3 Owns the method of repair works on the instructions and regulations

BGPM.02 «Perusal and development of typical schemes of automation»

Aims and objectives

This module will enable students to understand and perform standard schemes of automation, technical drawings of various parts, circuits using different techniques of painting, drawing and equipment of computer manufacturing of drawings.

Introduction to the Module

This module will give to students an understanding of the process of building a simple automatic control and regulation system.

In the design process of automation of technological systems design organizations should be guided by: the main technical areas in engineering enterprises of relevant industries, as well as in the development of control systems and automation means, from the perspective of the development of science and technology; results of research and development activities; advanced industrial experience in the field of automation of technological processes; excisting regulations for the design of the system of automation of the technological processes, duly approved, as well as the standards of automation projects; norms and rules of construction design, sanitary, electrical, fire and other requirements.

Project materials (drawings, explanatory note, estimate, etc..) must have the minimum required volume and must be written clearly and concisely in order to make their use not cause trouble.

It is important that the drawings and schemes have been carried out in accordance with international standards and agreements. This will help to avoid errors in the interpretation, which may lead to failure and malfunction of the automation systems.

Understanding how the graphical methods can be used to transmit information about the technical products is an important step for everyone who discusses his/her career in the technical field. This module introduces students to the principles of technical drawings and their use by the art of drawing by hand and computer-aided design (CAD).

Students will begin with performing manual sketches of simple technical products using graphical techniques that allow you to create three-dimensional images. A number of standard components such as retaining devices, are sketched together in one piece and with other foraminous elements. Students are then acquainted with the more formal drawing techniques, which corresponds to the Kazakh standards and is introducing into practice through a series of exercises on the drawing. There will be used consistent style as the trainees will draw some of the components and simple technical units.

Studying the principles of technical drawing, students will move further using the two-dimensional CAD system (2D) to create drawings using the basic settings, drawing and editing commands.

When constructing block diagrams students will be able to understand the principles of creating of hierarchy and automation systems.Circuit diagrams are used to study the operating principle of the system, they are necessary in the manufacture of commissioning and exploitation.

Drawings of typical structures define the designing of components and products

for installation of the equipment, automation tools, electrical and tube wiring, and serve as the basis for the development of working documentation for serial production of these units.Comprehensively, the module will develop the ability of students to create technical drawings and will allow them to compare the use of manual and computer methods of creating technical drawings.

The results of studies

After completing this module students have to:

1. Know the classification of automation schemes, type of supply.
2. Know and apply the existing state standards on the designation of the functional elements of automation circuits and schematic diagrams.
3. Compile shareware graphics and lettering schemes of functional elements of automation and electrical schematic diagrams.
4. Know and apply information and communication technologies in the preparation of automation schemes.

Module content

1. **Know the classification of automation schemes to destination, type of supply.**

Structural scheme of automation - single-level and multi-level, centralized and decentralized. Assignment of block diagrams, rules for the implementation and execution.

Functional automation schemes: conventional image of processing equipment, communications, units of control and automation tools, indicating the links between process equipment and automation equipment, as well as the relations between the individual functional units and automation elements. Schematics for the type of supply - electric, pneumatic, hydraulic. Schematic diagrams of operational control, regulation, control and supply.

2. To know and apply the existing state standards on the designation of the functional elements of automation circuits and schematic diagrams.

The requirements of existing standards for the designation of technical equipment and piping. Conditional numerals of pipelines for liquids and gases.

Rules for execution of schematic diagrams. Main concepts: elements of circuits, the device, the functional group, the functional circuit , interconnection line. Requirements for the development of schematic diagrams: reliability, simplicity and cost-effectiveness, clarity of the scheme in the emergency operation, ease of operation and clarity of operational design. Conditional graphical and alphanumerical designations of scheme elements. System of designations of circuits in electrical circuits.

3. Compile shareware graphics and lettering definitions of elements of automation functional schemes and electrical schematic diagrams.

Conditional graphical definition of instruments and automation equipment according to interstate standard - GOST 21.208-2013. The main character definition of measured values and functional features of the instrument. Rules for the con-

struction of symbols instruments and automation on schemes. Graphics, letters and numerals.The dimensions of symbols - basic and permissible (a device, unit, functional unit of digital technology and excecutive mechanism).

4. Know and apply information and communication technologies in the preparation of automation schemes

Preparing a template: a standardized drawing sheet, for example, border, stamp, logo; save to file.

SAPR systems : computer system such as a personal computer network; output devices such as a printer, plotter; storage, such as a server, hard disk, CD, flash drive; packages of 2DSAPR programs, for example, AutoCAD, COMPASS and others.

Creation of technical drawings: configuration commands, for example, measure, grid, picture layer; drawing commands, for example, coordinate entry line, bend, circle, shot, polyhedra, shading, text, size; editing commands, such as copy, move, erase, cool, image, balancing condition, increase the diagonal pair, rounding.

Storage and presentation of technical drawings: save your work in the form of an electronic file, for example, on a hard drive, server, flash drive, CD; create hard copies, such as printing, design, scale in size. Development of the simplest model functional schemes of control and control, regulation, signalization and blocking.

Design of automation schemes in accordance with regulatory documents.

Learning outcomes and assessment criteria

Learning outcomes upon successful completion of this module the learner	**Assessment criteria Learner must**
LO1 Knows the classification schemes of automation, type of food.	1.1 Select a power scheme on the technical parameters of the instruments and means of automation. 1.2 Choose the scheme of control, regulation and management in their assignments. 1.3 Use the appropriate scheme in their professional activities.
LO2 Knows and applies the current standards to describe the elements of functional schemes of automation and schematic diagrams.	2.1 Be able to determine the functionality of the item on its symbol on the scheme. 2.2 Use of standards in the marking scheme elements. 2.3 Determine the list of scheme elements of the technical characteristics and reference designator.

LO3 compose semi-graphical and letter symbols of elements of functional schemes of automation, and schematic diagrams.	3.1 Be able to create symbols of instruments and automation means for the measured parameter and their functions in accordance with applicable regulations and Standards. 3.2 Be able to mark connecting lines in the functional schemes, depending on the transmitted signal. 3.3 Be able to read and define the position of the devices on the functional diagrams of automation. 3.4 Be able to read and apply alpha-numeric reference designators on the schematic diagrams.
LO4 Knows and applies information and communication technologies in the preparation of schemes of automation	4.1 Be able to apply graphical editors for the design of automation schemes. 4.2 Comply a list of scheme elements to fill in the sheet. 4.3 Prepare drawings according to the requirements of normative documents.

BGPM.03 “Occupational health and safety compliance”

Aims and objectives

This module will give students an understanding of the basic rules and laws for the protection of health and safety and how they apply in practice to ensure safe working conditions.

Introduction to Module

The health of people working or residing in any production environment is very important. All the workers expected that they will be able to carry out their work in a safe manner so to avoid any negative effect on their health and wellbeing. In fact, many organizations not only reduce risks and carry out improvements to the working environment, but also trying to make their own working environment better for others, making it a competitive advantage when applying for new staff.

Occupational safety and health in the workplace are measures designed to protect the health and safety of staff, visitors and a wide range of persons who may be affected by work activities.

Health and labor, often controlled by laws and regulations and laws are constantly reviewed and updated. It is important that these organizations know about the changes and support their level of self-awareness according to updates.

This module will give students an understanding of the hazards and risks associated with health, safety and wellbeing in workplaces where there is a technique, as well as related laws and regulations. From students will also be required to undertake full risk assessments and to evaluate the importance of risks that occur at workplaces, and measures are being taken to work with them. Students will also learn the principles of reporting and recording of accidents, incidents, in the context of the rule of law.

This module can form a key component within many training programs, as this component is highly valued in many industrial, manufacturing and engineering situations.

Learning outcomes upon successful completion of this module the learner:

1. To understand the basic laws and regulations on health and work.
2 To know how to identify and control hazardous situations in the workplace.
3. To be able to carry out a risk assessment, establishing control measures.
4. To understand the methods used when recording and reporting accidents and incidents.

The contents of the module

1. To understand the basic laws and regulations on health and labor protection

Key features of laws and regulations: legislation, for example, the Labor code of the Republic of Kazakhstan, and so on.

2. To know how to identify and control hazardous situations in the workplace

In the workplace: methods to identify hazards, for example, the acts, the analysis of the significant risks, forecasts of the results or consequences of these risks, the use of data on accidents, careful consideration of working methods.

Working environment: the study of the workplace and its potential hazards, for

example, confined spaces, working over water or at height, **the risk of electric shock**, chemicals, noise.

Hazards which become risks: identifying obvious or important risk; the opportunity to cause harm; choosing the right control measures; electrical safety, for example, identify and control hazards, cause of injury, effects of electricity upon the body, the overload of the network; mechanical safety, for example to identify and control hazards, cause of injury, rotating equipment, sharp corners; safety devices, e.g. differential protection device (UPD), protection, safety in a crash, sensors.

3. To be able to carry out a risk assessment, establishing control measures

Risk assessment: the items/areas that should be assessed, for example, work machine, the work area; five steps (principal danger, who likely will suffer/will suffer damage, assessment of risk and determination of the reliability precautions, data recording, analysis, assessments).

The use of control measures: for example, eliminating the need (with the exception of the project), use of recognized procedures, substances control, guarding device, process evaluation recovery and evaluation of manual processing, regular inspection, use of personal protective equipment (PPE), training of personnel, other personal procedures relating to the health, safety and well-being.

4. To be able to render first aid in case of accidents

Accidents at work, dangerous and harmful workplace factors; investigation, recording and analysis of accidents on manufacture; provision of the first (pre-medical) care for bruises, wounds, thermal and chemical burns, electric shock.

Learning outcomes and assessment criteria

Learning outcomes upon successful completion of this module the learner	**Assessment criteria Learner must**
LO1 Understand the main laws and regulations on health and labor protection	1.1 compose in compliance with legal and organizational issues of labor protection: the basics of the legislation on labor protection in the Republic of Kazakhstan; system of standards for labor safety (occupational safety standards); organization of work on labor protection 1.2 apply knowledge on labor protection in professional activities

LO2 Knows how to identify and control hazardous situations in the workplace	2.1 to be able to identify deviations and violations of security of technological processes and equipment; 2.2 to evaluate possible negative impact of dangerous and harmful workplace factors;
LO3 Know how to conduct a risk assessment, establishing control measures	3.1 Select and use hand tools, power tools, pneumatic tools; 3.2 Observe safety measures when working with hand tools; 3.3 Use personal protective equipment; 3.4 Apply electrical safety devices and guards;
LO 4 Can provide first aid to victims in case of accidents	1.1 Choose how to provide first aid depending on the injury 1.2 Provide aid for electric shock; 4.3 Own techniques of first aid: stop bleeding, treatment of wounds, burn and fractures; transportation of the victim.

BGM.04 " Economic basis of entrepreneurial business "

Aims and objectives

This module will give students the basics of entrepreneurship in a market economy.

Introduction to Module

The modern period of development of Kazakhstan gives a lot of opportunities to anyone who want to try to apply their entrepreneurial skills.

Large high-tech manufacturing is the backbone of the economy of our country. But history has shown that small business competes with big business, as it is more flexible, more mobile and sustainable in crisis conditions.

In the first part of the module students become familiar with basic market economy concepts: demand, supply, competition, monetary circulation.

In the second part of the module, students will learn such issues as the content and culture of entrepreneurship, the process of registration, taxation, production costs and results of business activities.

In the final part of the module the students have to study the technology for marketing research, business plan and development, commercial contracts in the business.

Learning outcomes

upon successful completion of this module the learner

1. Knows the economic categories and laws, the laws of development of economic system; is able to analyze the socio-economic situation in the country.
2. Knows normative legal acts regulating entrepreneurial activity, list of documents and steps required for business registration.
3. Knows the structure and is able to reach the main sections of a business plan of a small business.

The content of the module

1. To know the economic categories and laws, the laws of development of economic system; be able to analyze the socio-economic situation in the country.

It is impossible to do business without knowing the basics of the functioning of the market mechanism and how the socio-economic situation in the country may affect entrepreneurial activity.

The market is an endless series of transactions of purchase and sale, carried out by special laws – the laws of supply and demand. These laws dictate the "rules" of behavior of sellers (producers) and buyers (consumers). In terms of market the balance between demand and supply of goods is constantly changing, from time to time reaching equilibrium. Balance between supply and demand at any given moment is called market conditions. Students should know these categories: need, demand, supply, market equilibrium, market-clearing price, elasticity of supply and demand, competition, methods of competition.

2. To know the normative legal acts regulating entrepreneurial activity, list of documents and steps required for business registration.

Entrepreneurial activity can be carried out without formation of legal entity (individual entrepreneurship) and the conformation of a legal entity.

Commercial legal entity is an organization pursuing profit as the main goal of

its activities. Commercial entities: partnerships, joint stock companies, production cooperatives. A legal entity is considered created from the moment of its state registration. A legal entity acts on the basis of constituent documents: the Memorandum and articles of Association.

Private businesses can be attributed to:

- small businesses;
- medium-sized enterprises;
- large businesses.

The criterion is the average number of employees.

3. To know the structure and be able to reach the main sections of a business plan of a small business.

In market economy businessmen cannot achieve success unless planning their activities clearly and effectively. Among all the variety of forms of business there are key provisions to be applied in all areas of business. And it is necessary in order to timely prepare and to circumvent potential difficulties, thus reducing the risk in achieving goals.

One of the main documents in the entrepreneurship is business plan, which includes the business idea, marketing plan, financial plan and plan for the staff. It is also necessary to determine the amount of seed capital that will be required to complete the work.

Learning outcomes and assessment criteria

Learning outcomes upon successful completion of this module the learner	**Assessment criteria Learner must**
LO1 Knows economic categories and laws, the laws of development of economic system; able to analyze the socio-economic situation in the country	1.1 Explain the concept of «demand,» «supply» 1.2 Define and explain the law of demand and law of supply. 1.3 Explain the concept of «elasticity of supply and demand 1.4 Explain the maintenance of price and non-price methods of competition 1.5 Be able to explain functions of banks and the nature of monetary circulation in the country
LO2 Knows the legal acts regulating entrepreneurial activity, list of documents and steps required for business registration.	1.1 Know the legal form of entrepreneurial activity 1.2 Be able to objectively assess personal qualities and motivation to start a business 1.3 Know the procedure of business registration and required documents 1.4 Be able to explain the features of taxation of small businesses

LO3 Knows the structure and knows how to make the basic sections of a business plan for a small business.	1.1 Be able to analyze and calculate the starting capital 1.2 Know sources of start-up capital financing 1.3 Know the contents of the business plan 1.4 Be able to analyze market conditions and formulate marketing plan 1.5 Be able to calculate the main indicators of the financial plan. 1.6 Know the procedure for the conclusion of contracts in small business.

PM01 «Mounting of the control measuring tools»

Aims and objectives

This module will give students an understanding of the technical documentation for manufacturing and installation works for instrumentation and automation equipment, basic techniques and methods of installation works, testing and commissioning.

Introduction to the Module

This module gives students an idea about the organization of works on installation of instruments and automation equipment, structure erection departments, the appointment of jobbing plants and erection areas on the objects, the composition of the work.

Students should know the structure and content of the technical documentation for construction works, the rules of implementation of schemes of external connections, circuit-switching schemes, model installation drawings of the devices, setting fittings and selected devices.

They should know methods and technical requirements for installation of boards, panels and cabinets, installation of devices and equipment on them. Also, installation of selected devices, base constructions for technological equipment and pipelines.

This module will provide guidance on the installation of primary measuring converters of temperature, pressure, flow, level, weight and other technological parameters.

Installation of controllers and actuators. Installation of industrial controllers and blocks the APCS.

During industrial training the students receive skills of work with equipment, instruments and installation products.

Safety when carrying out construction works.

In the process of industrial training it is provided skills to operate the tools, carry out erection work instructions and standards.

Learning outcomes

On completion of this module students should:

1. Know the General principles of organization of construction works of the automated systems.
2. Know the composition and contents of design documentation for the installation of automated systems.
3. Know the composition of works on installation of pipe and electrical wiring of automation systems.
4. Know the composition of works on installation of devices and automation means.

The content of the module

1. To know the General principles of organization of construction works of the automated systems.

Structure of construction management. The purpose and function of administrative personnel, industrial engineering department, section of pre-production. Mounting preparation workshops, their purpose, running jobs, equipment, tools and materials. Organization and erection area at the facility. Requirements of the

installation company in the construction readiness of the object. Preparatory work. The role of standardization in ensuring the quality of installation works.

2. To know the composition and contents of design documentation for the installation of automated systems.

The development phase of an automation project. Technical project and working documentation, the appointment and composition. The structural scheme of the control and management of hardware components. Functional diagrams of automation. Concepts of control, regulation, control, alarm, power, protection and locking. General views of boards and panels. Diagrams external wiring. Plans arrangement of equipment and wiring. Customized specifications.

The project of manufacture of works. The procedure and processing of design estimate documentation before beginning the installation.

3. To know the composition of works on installation of pipe and electrical wiring of automation systems.

Technical documentation, installation of pipe and electrical wiring.

Classification of pipe transactions used in the systems of automation of technological processes. A breakdown of the runs of pipe transactions and the reference to the construction and technological designs. Strip the outer and inner pipe transactions. Strip tube blocks.

Laying wirings in an open way, in tunnels, in cable channels, cable ducts and protective tubes. Continuity test and marking of electrical wiring. Testing and commissioning.

Safety in the installation of pipe and electrical wiring.

4. To know the composition of works on installation of devices and automation means.

Typical installation drawings embedded designs and selected devices. Erection and operating instructions of instrumentation and automation manufacturers. Pre-installation testing of instrumentation and automation. The installation of devices on-site and on billboards. Technical requirements to installation of transducers of temperature, pressure, flow, level, concentration and other process parameters.

Safety in the installation of devices and automation means.

Learning outcomes and assessment criteria

Learning outcomes upon successful completion of this module the learner	**Assessment criteria Learner must**
LO1 Knows the general principles of organization of construction works of the automated systems	1.1 Explain the structure and erection management, the appointment of the individual units and installation sites 1.2 Be able to organize work on the installation at the given sector.

LO2 Knows the composition and content of design documentation for installation of automated systems	2.1 Determine the composition of working drawings for execution and installation works 2.2 Be able to use the typical installation drawings for the installation of devices and selected devices 2.3 Be able to work with the erection and operating instructions of instruments and equipment manufacturers
LO3 Knows the composition of works on installation of pipe and electrical wiring of automation systems	3.1 Select and use installation tools and accessories for laying of pipe and electric lines. 3.2 Perform the laying, marking and connection of wires and cables 3.3 Perform a strip impulse, command, supply and support pipe transactions 3.4 Observe safety requirements during installation
LO4 Knows the composition of works on installation of devices and automation means	4.1 Select and apply the methods of installation of devices according to the manufacturer's instructions. 4.2 Be able to control the correct installation and connection of devices. 4.3 Master the skill of safe operations.

PM02 “Exploitation and technical maintenance”

Aims and objectives

This module will give students an understanding of the organizational structure and maintenance of instruments and automation means

Introduction to module

This module will give students an understanding of the range of activities, including the preparation and use of automation for the purpose, their maintenance, storage and transportation.

The preparation of the instruments, means and systems automation for usage should be started simultaneously with construction works at the facility. The essential in the preparation of the instruments — commissioning work on bringing them to a state where they can be used for operation.

The main conditions of reliability of automation, ensuring their efficiency and durability, are: the strict implementation of the staff rules of technical operation and safety; timely and efficient implementation of maintenance and preventive maintenance of instruments and controllers.

The module will give students knowledge of the main tasks of the metrological service (calibration of instruments, development of automation and quality assurance).

The main tasks and functions of the service include: ensuring maintenance, removal and installation of the devices, execute current and capital repair, calibration, installation and commissioning; scheduling technical papers, applications, devices, equipment, spare parts, materials and documentation; control over the receipt of instruments and automation equipment, providing conditions for proper storing, issuing, preparation of acts and complaints; monitoring the operation and use of measuring instruments and automation in the enterprise.

In the process of industrial training it is provided skills of maintenance and repair work according to instructions and regulations.

Learning outcomes

On completion of this module students should:

1. Have an idea about the organisation and equipment of metrological laboratories.
2. Have an idea about the order of verification, calibration and certification of instrumentation and automation systems.
3. Be able to perform maintenance of instruments and automation.

The contents of the module

1. To have an idea about the organisation and equipment of metrological laboratories.

The laboratory should be located in separate buildings or in isolated areas. The basic requirements for the laboratory premises: a) no vibration, electrical interference; b) illumination of workplaces not less than 150 Lux, c) indoor temperature should be 20±50C and relative humidity of 50-80%; power AC 220V±2V, barometric pressure 750±30 mm Hg.St; g)the laboratory must be warehouses for storage of reserve equipment and spare parts. In the lab should be a full range of exemplary

measurement devices for all types of measurements, attorneys in the bodies of the state metrological service. In the laboratory must be a full set of normative-technical documentation, methods and means of verification, specifications, Standards and technical documentation for measuring instruments.

There is must be spare parts for repair of measuring devices, as well as provision of equipment for replacement check, exemplary and working measuring instruments.

2. To have an idea about the order of verification, calibration and certification of instrumentation and automation systems.

Verification of measurement means – set of operations carried out by bodies of the state metrological service with a view to identify and confirm the compliance of means of measurement (MM) in accordance with technical requirements. Measuring instruments are subjected to the following verifications: a) primary verification at release MM from production; b) periodic verification is in operation and the storage at time intervals according to the schedule agreed with the national metrological service; C) extraordinary verification is performed at damage verification seal, seals, loss of certificate verification, after prolonged storage, repair and adjustment of the device; g) inspection and verification carried out by the bodies of metrological supervision.

Calibration of measuring instruments – set of operations performed by the MM calibrator, not subject to the state metrological control and supervision with the aim of establishing the actual value of the measured parameter.

Verification and calibration shall be in accordance with the requirements of normative documents (methods and means of verification approved by the verification scheme, instructions, and methods of verification).

3. To be able to perform maintenance of instruments and automation means.

The technical work undertaken by the metrology and automation service is divided into corrective and preventive. Unplanned work is reduced to the replacement of the failed measuring instruments and automation means. Preventive works include: a) inspection; b) current and capital repair; C) the verification and calibration of measuring instruments.

Maintenance is performed throughout the work period between two planned repairs and includes: a) technical supervision, which is carried out continuously with the aim of inspection of measuring instruments and automation systems; b) preventive work is carried out in accordance with the requirements of the factory instructions; C) routine maintenance is the minimum amount of work that ensures the normal operation of the instrument, and automation technology until the next planned repair.

Learning outcomes and assessment criteria

Learning outcomes upon successful completion of this module the learner	**Assessment criteria Learner must**
LO1 . Has knowledge about organization and equipment of metrological laboratories	1.1 Understand the purpose of metrological laboratory 1.2 Know the basic requirements for the laboratory premises 1.3 Know the structure and purpose of equipment for Metrology lab
LO2 Has an idea about the order of verification, calibration and certification of instrumentation and automation systems	2.1 Be able to apply regulatory and technical documentation on the methods and means of verification 2.2 Have the skills to conduct the verification and calibration of instruments 2.3 Be able to prepare technical documentation on the results of the verification and calibration of instruments
LO3 is able to perform maintenance of instruments and automation means.	3.1 Be able to organize a workplace for performance of works on maintenance of instruments and automation means. 3.2 Carry out technical supervision to check the status of instrumentation and automation systems 3.3 Perform preventive maintenance according to the factory requirements instructions 3.4 Carry out routine maintenance to ensure the normal operation of instruments and automation equipment before the next scheduled maintenance.

PM.03 “Repair works of control measuring tools”

Aims and objectives

This module will give students an understanding of the organizational structure of repair service and parts of repair work of instrumentation and automation means.

Introduction to the module

The main objective of maintenance services: maintenance in operational condition of all parks of equipment and automation, providing high quality repair and reduction of expenses of time and means for maintenance of instruments and automation means.

There is three-tier repair system of measuring: 1.At the workplace by using the repair and calibration laboratories; 2.At the repair sites; 3.At repair factories or factories of measuring instruments manufacturers.

Depending on the nature of the failure, the extent of the development resources and the complexity of recovery are distinguished: current, average and capital repairs. 1. The current repairs include: elimination of certain faults by replacement of components without complex diagnostic equipment. It’s the execution of simple operations on the adjustment of MM to bring the characteristics to the regulated values. 2. Medium repair – included working current repairs, and time-consuming operations for the replacement or restoration of items to a partial recovery of the MM resource, with subsequent technical inspection of all component parts of the device, defects and tuning. 3. Overhaul – the device is almost completely dismantled, determine the technical state of each component, element of design. Eliminate heavy damage and failure, requiring sophisticated diagnostic equipment, replacement and repair of failed elements and components, setting and adjustment and subsequent testing.

Repairs are distinguished by the method of execution: 1.Detailed method of repair – the restoration of MM by replacing component elements. The disadvantage of this method is large, the complexity of diagnostic equipment, high requirements to qualification of employees, the amount of repair documentation description of the method of troubleshooting failures; 2.Aggregate – replacement of failed assemblies (components, boards, blocks) new or refurbished. Advantages: minimal repair time, simple process equipment, low the qualifications of the maintenance personnel. Disadvantages: high cost of spare parts (nodes, blocks).

At the end of the repair equipment is subjected to calibration with the mark in the forms of the device and other normative documents.

Learning outcomes

On completion of this module students should:

1. Have an idea about the organization of repair work.
2. Have an idea about hardware jobs technicians.
3. Be able to produce technical documentation for repair of equipment.
4. Be able to perform certain types of repairs for instruments and automation means.

The contents of the module

1. To have an idea about the organization of repair works

Licensing requirements and conditions for the implementation of activities on repair of measuring instruments (MM) are: a) the availability of appropriate equipment and compliance with production technologies ensuring the MM repair in accordance with established specifications and standards; b) the existence of organizational and technical capacity to perform initial verification refurbished MM used in areas of the state metrological control and supervision of the implementation of the primary calibration or refurbished MM, are not subject to verification; c) the availability of necessary for the manufacture and repair of production facilities that meet the requirements of regulatory and technical documents; d) the presence of the individual entrepreneur and the employees of the legal entity of higher or secondary vocational education or higher or secondary vocational education under the condition of passage or re-repair and construction on special training courses in the state metrological services, or the company with a representative state metrological service.

2. To have an idea about working places hardware of technicians

Jobs technicians shall be equipped with: 1.Special schemes; 2.Devices for defects of electronic pneumatic components; 3.Devices for short circuit detection coils; 4.Summed up the air, water and electrical power; 5.Installed exhaust device; 6.Have sufficient natural and artificial lighting of the workplace; 7.Floor area not less than 5m2 per person; 8.A separate room for repair of mercury devices, appropriate special requirements.

3. To be able to produce technical documentation for equipment repair.

To an accepted for repair equipment it is repair card indicating the date of issue after the repair, the spine of which is transferred to the customer. The defective act is made by group, then the equipment is cleaned and painted. The repair devices supply the necessary spare parts and materials. The time for repairs is set in the map, after which the devices are sent to the repair group. The name of the maintenance fitter is written in the repair map.

After repair the instrument is sent to the verification group, where they calibrate and state verification. With the stigma of state verification devices are given back to the group, where is checked the correctness of the repair card, the presence of entries in the passport or the certificate. After the transferring of the passport with a mark of repairs and filling repair card device is transmitted to the customer by the presentation of the rootlet repair cards.

4. To be able to perform certain types of repairs for instruments and automation means

Types of work at the current repairs: 1.Replacement elements, exhaust resources, troubleshooting; 2.Partial disassembly and adjustment of moving parts with the elimination or replacement of damaged parts, cleaning and lubrication of nodes; 3.Quality control isolation of power circuits and measurements; 4.Correction of seals, clearances, gasket seals, replacement of glasses, scales; 5.Troubleshooting in the joints of the moving parts, test the amplifiers, motors, movable contacts, setting up governing parts of MM and automation means.

Types of work at major repair: 1.Installation and adjustment of scales and dials; 2.The renovation of the buildings and installation of explosive surface equipment; 3.Complete disassembling and assembling of measuring parts and separate assemblies, flushing, repair and replacement of parts; 4.Checking of the measuring system, adjustment and adjustment of the readings, preparing it for submission to the verification officer; 5.Disassembling and assembling of mechanisms of entries and their audit, cleaning and replacement; 6.Repair of relays, sensors, actuators, controllers, electronic equipment or the replacement of more than perfect, replacement of faulty lines, wiring, alarm circuits.

The practical development of certain types of repairs, skill and qualification of the student will depend on his knowledge and skills acquired, including during passage of an industrial practice.

Learning outcomes and assessment criteria

Learning outcomes upon successful completion of this module the learner:	**Assessment criteria Learner must**
LO1 . Have knowledge about the organization of repair works	1.1 Understand the purpose and types of repairs 1.2 Know the basic requirements for premises of repair plants
LO2 Have an idea about hardware of maintenance fitter	2.1 Know the composition and assignment of equipment of repair plants. 2.2 Be able to organize the workplace for performance of works on repair of devices and automation means. 2.3 Be able to prepare technical documentation on the results of the verification and calibration of instruments
LO3 Know how to produce technical documentation for repair of equipment	3.1 Be able to perform fault diagnostics of devices for making up repair cards 3.2 Be able to make an application for spare parts and materials for repair 3.3 Use of technical datasheets and instructions for the repair of the instruments Perform preventive maintenance according to the factory requirements instructions 3.4 Carry out routine maintenance to ensure the normal operation of instruments and automation equipment before the next scheduled maintenance.
LO4 is able to perform certain types of repairs for instruments and automation means	4.1 Use tools and laboratory equipment 4.2 Perform repairs in accordance with the qualifications and job description 4.3 Comply with safety requirements while performing repair work.

PM.04 “Design of control and automation systems “

Aims and objectives

The purpose of studying of the module is to develop student concepts of the design process, knowledge, and skills in the basics of designing automated control systems for technological processes.

Introduction to module

This module gives students an understanding of the challenges and techniques of designing control systems of technological processes.

Control system of technological processes based on obtaining information about the process flow, receiving information about technological parameters and condition of technological equipment and the control system.

Measurement channels are the most difficult part of management systems and require in-depth knowledge to obtain reliable measurement results. The quality of the data depends on the accuracy of measuring time performed verification or calibration, and the accuracy of measurements, correctness of the system of grounding, shielding and cabling. Measuring channels of automation systems, in contrast to the measuring instruments, are created “in the field”, that is the cause of the error. Many problems arise while there is performing statistical processing of measurement results.

To obtain reliable results requires knowledge in the field of Metrology, mathematical statistics, theory of random processes, information theory, and electronics.

Development of automatic management equipment and electric mechanisms that are part of control systems of technological processes requires knowledge of pneumatic, electric and hydraulic actuators, their application in the technological processes and management systems.

Real-time control system and automatic regulation of technological process parameters require alarms on limit values of parameters of the object and the condition of the equipment, completing the process.

Quality automation systems and its performance depends on the equipment control system, means for obtaining initial information about the parameters and status of equipment of the process of selection of control devices, methods of influence of regulatory signals on the parameters of the control object, methods of control, transmission and processing of information, its visualization, the ability to transfer control to operating personnel when it is needed.

The decisions are taken at the design stage, affect the technical and economic indicators of the management system and the quality of the products. They are based on a detailed study of the flow of the process as a control object. It is important to be able to analyze the technological object of control, to identify exposure to input control signals and disturbances, to develop ways of influencing the object of management.

It is important to know the nomenclature of manufactured industrial instrumentation and control, automation means. To know their device, principles of operation, technical characteristics, the applicability in real industrial conditions. It is important to be able to create a closed loop regulation with feedback using the chosen controls, automation.

The implementation of the control system based on project documentation of

the automated object, which is developed and supplied according to the normative documents, international standards. Project documentation is also used in the setup, configuration, maintenance and operation of control systems.

Module describes the procedure to create the project of automation of technological processes in metallurgy and energy that are applicable to other industries. This procedure is standard, but has some differences as applied to a specific type of manufacturing process.

The module contains information about the industrial control objects in metallurgy and energy, their specifications, composition, requirements for their management. The module provides practical skills in developing project documentation on the basis of optimal choice of composition of instruments and automation equipment in the control system.

The module is based on application of normative documents and standardized procedures design, professional knowledge of the modules used in the training of specialists in automation of technological processes, skills acquired in the course of production and training practices.

The module is used for the preparation of professionals involved in development, maintenance and operation of systems of local level management in metallurgy, electric power and other industries.

Learning outcomes

On completion of this module students should:

1. Know the technological processes of metallurgy and energy which will be managed by requirements for the control and regulation of their basic technological parameters.
2. Know the methods of obtaining reliable information about technological parameters, methods and means of measurement, ways of processing the information received.
3. Know the applicability, principles and technical characteristics of the devices and automation means, electrical, pneumatic and hydraulic actuators within the control system.
4. Know the ways of shaping the contours of control and regulation, to choose the devices and means of automation in the control system.
5. Be able to use normative documents and international standards in the development and execution of design documentation used in the implementation of automation systems.
6. Use computer technology and computer aided design in the development and execution of design documentation control system.

The contents of the module

1. To know the technological processes of metallurgy and energy which will be managed, requirements for the control and regulation of their basic technological parameters.

The concept of technological process as an object of regulation. Continuous processes and cyclical, discrete processes. Metallurgical technological processes in power engineering, General installation as automation objects. Process parameters: temperature, pressure, flow, level, mass, speed, position, radioactivity, density, etc. the Need for control and regulation of technological process parameters to achieve high quality

delivery process. The disturbance acting on the control object: internal and external, measured and is not available for measurement, continuously influencing and intermittent. Regulation as an instrument of compensation of the perturbation. Material flows in the process. The ability to change parameters of material flow for process control.

2. Know the methods of obtaining reliable information about technological parameters, methods and means of measurement, ways of processing the information received.

The concept of the technological parameter of the control object as the measured physical quantity. The units of measurement of physical quantities. Measuring instruments. Conversion of physical quantities into signals suitable for analysis, processing and transmission. Methods of measuring process parameters. Fundamentals of Metrology. Of the measurement error. Measuring circuit: bridge, the differential inclusion of the primary Converter in the measuring circuit, the measuring circuit of direct and alternating current, calculations of electrical circuits to enable devices in the measuring chain. The concept of the power of the output signal, the concept of entrance resistance of the measuring circuit or device. Types of signals: electric, pneumatic, hydraulic. Natural and unified signals, digital and analog measuring signals DC and AC. The concept of sensor as a means of obtaining initial information about a technological parameter. Sensors with analog and discrete signal outputs.

3. To know the applicability, principles and technical characteristics of the devices and means of automation, electrical, pneumatic and hydraulic actuators within the control system.

Sensors as means of obtaining primary information. The concept and contents of the measuring channel. The devices in the measuring channel of constant and variable voltage, devices of pneumatic, hydraulic converters. The types and types of sensors. The device and principle of operation of temperature sensors, pressure, flow, level, density, etc. Sensors with analog and digital output signals. The concept of normalizing and the measuring transducer. Secondary devices, means

display information analog and digital. Control devices of analog and digital controllers direct-acting controllers position. Regulators positional and multi-positional. Electric, pneumatic, hydraulic actuators. Electric, pneumatic and hydraulic actuators, their characteristics, principles of operation and applicability.

4. Know the ways of shaping the contours of control and regulation, to choose the devices and means of automation in the control system.

The concept and scope of the loop control and regulation. Control system with one input and one output. Closed (with feedback) and open control systems. The functional elements of the system of automatic regulation with negative feedback. Their purpose in the regulatory system. Sensor, setpoint, the unit of comparison, a regulating device, the actuator, the regulator.

The combination and diversity of functions of elements of system of automatic control in the same or different devices/appliances. The nomenclature of modern automation devices produced by the industry. Manufacturers of automation equipment. The transmission of signals between the devices within the control system. Types of signals, transformation of signals: amplification, filtering, rectification, stabilization, analog-to-digital and digital-to-analog conversion. Analysis and cal-

culation of electric circuits of signal conversion, calculation electrical alignments and power devices in the same control loop. Types of actuators. The control circuit of the actuators. The types of control actuators. Regulators (RO), the calculation of the throughput characteristics of RO, RO choice in circuit of automatic control. The calculation of a narrowing device. The choice of cables, wires and pipe transactions.

5. To be able to use normative documents and international standards in the development and execution of design documentation used in the implementation of automation systems.

Stages of development for APCS and staging design. Project materials (drawings, explanatory note, estimate, etc.) Placement of automation panels, control panels, process equipment and pipelines, the determination of ways of presenting information about the state of the technological process and equipment. The choice of type of control – automatic or manual control (locally or remotely).

Normative documentation defining General requirements, the development, the design and the procedure of its acquisition. Initial data for designing. Functional scheme of automation, electrical schematic control, regulation, signaling, control electric mechanisms and pneumoautomatics, schematic diagrams power wiring diagrams and General arrangement drawings of switchboards and control panels, circuits, external electrical connections and pipe transactions.

6. To use computer technology and computer aided design in the development and execution of design documentation control system.

The organization of the workplace designer computer hardware and operating systems software, application software packages, printers, plotters, and CAD software etc. used in the development of project documentation, text and graphic editors.

Learning outcomes and assessment criteria

Learning outcomes upon successful completion of this module the learner	**Assessment criterias The learner should**
LO1 to Know technological processes of metallurgy and energy will be managed, requirements for the control and regulation of their basic technological parameters.	1.1 define the technological process, to specify its characteristics as an object of management. 1.2 Identify the disturbance acting on the process. 1.3 Know the input and output parameters of the control circuits. 1.4 Give a definition of the technological parameter, called the technological parameters to be monitored and regulated. 1.5 Explain the technological processes in metallurgy and energy, General industrial installations as objects of management. 1.6 Use basic technological schemes as the basis for the design of automated systems.

LO2 Know the ways of obtaining reliable information about technological parameters, methods and means of measurement, ways of processing the information received.	2.1 Apply methods and means of measurement to obtain reliable information about the measured parameter. 2.2 Estimate the error of measurement, choose the measurement in accordance with the requirements of measurement accuracy. 2.3 Develop and count measuring system, to analyze the principles of operation measurement applications. 2.4 Select power supplies automation, instrumentation, measurement channels. 2.5 Analyze the concepts of electronic devices and measuring equipment. 2.6 Know the devices for information display. 2.7 Storing information about measured parameters, processing, display, use.
LO3 Know the applicability, principles and technical characteristics of the devices and means of automation, electrical, pneumatic and hydraulic actuators within the control system.	3.1 become familiar with different types of sensors, their purpose and operating principles, output signals. 3.2 to Make the instruments and means of automation the circuits of control and regulation. 3.3 Select the devices in the circuit constant and variable voltage, compressed environments. 3.4 to Know the purpose of secondary devices, their functionality, types, to be able to choose their control options. 3.5 Analyze the work of controllers. 3.6 Know analog and digital controllers. 3.7 Know the direct acting regulators, the regulators position. 3.8 to Select the controllers in the control loop. 3.9 be Able to explain how the actions of regulatory bodies two-position and multiposition. 3.10 Know the types of LO. 3.11 Know the principles of operation and performance of electrical, pneumatic, hydraulic actuators. 3.12 Select the devices and means of automation in the design of circuits of control and regulation.

LO 4 Know the ways of shaping the contours of control and regulation, to choose the devices and means of automation in the control system.	4.1 Know the concept of loop control and regulation. 4.2 Know the control system with one input and one output. 4.3 Know closed (with feedback) and open control systems. 4.4 Call functional elements of the system of automatic regulation with negative feedback, to indicate their purpose in the regulatory system. 4.5 Know the nomenclature of modern automation devices produced by the industry, manufacturers of automation equipment. 4.6 Organize the transmission of signals between the devices within the control system. 4.7 Know the types of signals, transformation of signals: amplification, filtering, rectification, stabilization, analog-to-digital and digital-to-analog conversion. 4.8 Analyze and calculate electrical circuits for converting the signals to calculate electrical circuit coupling and power devices in the same control loop. 4.9 Know the types of the actuators. 4.10 Develop and maintain scheme management Executive mechanisms 4. 11 Develop control schemes actuators. 4.12 Select LO in the circuit of automatic control. 4.13 Calculate the orifice device. 4.14 Choose cable, wire and pipe transactions.

LO 5 to be able to use normative documents and international standards in the development and execution of design documentation used in the implementation of automation systems.	5.1 Know the stages of development of industrial control system and project design stages. 5.2 Develop project materials (drawings, explanatory note, estimate, etc.) 5.3 Place automation on boards, panels, process equipment and pipelines, the determination of ways of presenting information about the state of the technological process and equipment. 5.4 Select control – automatic or manual control (locally or remotely). 5.5 The use of standard documentation in development of design documentation for process automation. 5.6 Develop a functional scheme of automation, electrical schematic control, regulation, signaling, control electric mechanisms and pneumoautomatics, schematic diagrams power wiring diagrams and General arrangement drawings of switchboards and control panels, circuits, external electrical connections and pipe transactions.
LO 6 to use computer technology and computer aided design in the development and execution of design documentation control system.	6.1 Know the complete set of computer equipment for the organization of the workplace designer. 6.2 Know software, application software packages, CAD software used in the development of project documentation, text and graphic editors. 6.3 Have the design skills in the environment of a COMPASS or other graphic editors.

PM 05 "Checking-out of control and automation systems"

Aims and objectives

This module will give students an understanding of the complex adjustment operations as an important step in the introduction of automated systems in operation.

Introduction to module

The preparation of the instruments, means and systems automation to use should be started simultaneously with Assembly installation works at the facility. Essential in the preparation of the instruments — commissioning work on bringing them to a state where they can be used for operation.

Adjustment of the measuring systems is a complex verification and configuration, providing reliable information about values of controlled variables and the process. Commissioning should be carried out in three stages.

In the first stage, performed preparatory work, study and analysis of major design decisions and pre-installation testing of measuring instruments. At this stage, the customer provides premises and project documentation.

In the second stage, performed to verify the correct installation of measuring instruments, process control, Autonomous adjustment and training systems for inclusion in the work, to ensure that individual tests of the process equipment. Commissioning can be carried out simultaneously with the installation work.

In the third stage of the commissioning works on the complex adjustment systems of technological control and bringing their parameters to the values in which they are used during normal operation. For automation systems, including systems of locks and protection, the failure of which could be dangerous during commissioning shall be provided in the test program modes, simulating an emergency. For regulatory systems, the adjustment is static and dynamic control settings.

Letting established automation systems in operation as is done by individual nodes, and complex by installations, workshops, productions.

Learning outcomes

On completion of this module students should:

1. Know which work is performed in the process of pre-validation.
2. Know what is included in the offline setup.
3. Know the order and content of the second stage of commissioning of control systems and automatic control.
4. Know the scope of work of the third stage of adjustment.

The contents of the module

1. To know which work is performed in the process of pre-validation

Pre-installation testing of devices and means of automation, is input and is conducted to verify the basic technical characteristics required by the instructions of the manufacturers. Devices for checking parts and special tool must deliver a customer in the testing laboratory. When the test is performed: adjusting individual elements such as sensitivity, zero, scale span, adjust control points, digitization or graduations of the scale, setup, setting of parameters of operation of the elements of signaling, blocking, etc.

The results of pre-installation checks are recorded in the act or the certificate on the devices. Faulty equipment, inadequate project delivered to the customer for replacement, repair or pregraduate.

Dismantled without the technical documentation of instrumentation and automation for verification will not be accepted.

2. Know what is included in the offline setup

Autonomous adjustment of technical means begins with works in the Central control room and in the premises automation. Is: 1.Check switching boards, panels and mounted lines; 2.Preparation for inclusion of power supply circuits; 3.The test voltage is applied to the shield, which are used safety precautions for installation work; 4.Gradually the positions of the devices switch on equipment of the Central control; 5.Using artificial signals test the functionality of each position of automation; 6. Simulating a change in a variable, check the operation of secondary devices, transmitting signals to computer control systems (TSCCS), alarm and automatic control systems; 7.Controlling the output to the actuator is shut off remote control, switching from a manual-automatic by checking the phasing of the output of the controller; 8.When setting alarm circuits, blocking and control are checked all the logical and temporal dependencies, adjust the time relay, command devices, position of contacts; 9.After setting up the equipment in the Central control station and connecting the primary sensor and transducer, is the start-up and commissioning of separate circuits of measurement and regulation; 10.Simultaneously with carrying out individual tests of automatic control systems and comprehensive testing of process equipment, is the inclusion of instrumentation and automation systems; 11.All work in this phase is conducted under the supervision of Adjusters-engineers on the instructions and according to schedule start-up units.

3. To know the order and content of the second stage of commissioning of control systems and automatic control

In the second stage of commissioning works is an offline process systems process control and automation, installation of which was completed at the facility.

Scope of commissioning work:

1) Verification of the completed installation;

2) Address negotiation and phasing parameters of the communication channels, verifying the passage of the signals;

3) Check the parameter setting and the enable circuits, power supplies;

4) Check and configure the logical and temporal relationships, protection systems, alarm, lock and control;

5) Phasing and control of the actuators characteristics;

6) Verification of passage of the signals;

7) Preliminary determination of the characteristics of the object, the calculating and setting of instrument parameters;

8) Preparation and inclusion of control systems and automation for individual tests;

9) Autonomous adjustment of channels and objectives of process control;

10) Design of protocols for the verification of locking system and other documentation.

4. To know the scope of work of the third stage of setup

In the third stage are complex systems monitoring and automation, to bring their settings to the values at which the system can operate in operation.

Scope of commissioning work:

1) Definition of mining devices and elements of control signalling, protection and control provided by the project and technological process;

2) Definition of capacity shut-off and regulating equipment, correct operation of limit and contact switches;

3) Determines the flow characteristics of the regulators and bring them to the required form by means of the adjustment elements;

4) Preparation for inclusion and the inclusion of control systems and automation together with technological equipment to ensure comprehensive testing;

5) Specified static and dynamic characteristics of the object, adjusts the value of the tuning parameters of systems, taking into account their mutual influence;

6) Test and determine the suitability of the established systems of exploitation;

7) Documentation and commissioning of systems in operation.

Commissioning of control systems and automation is the most difficult and responsible types of technical works, the quality of which depends on trouble-free systems of automatic control.

Learning outcomes and assessment criteria:

Learning outcomes upon successful completion of this module the learner:	**Evaluation criteria The student should**
LO1 . Knows what work is performed in the process of pre-validation.	1.1 Understand execution project commissioning operations and event safety 1.2 be able to organize and perform work for pre-check devices site.
LO2 Knows what is included in the offline setup	2.1 Identify the sequence of works on Autonomous adjustment instrument at the object 2.2 be able to use devices and equipment for commissioning
LO3 Know the order and content of the second stage of commissioning of control systems and automatic control	3.1 Verify the correct implementation of construction works. 3.2 verify setup and enable circuits, power supplies 3.3 Perform more complex work on the adjustment under the guidance of a service engineer. 3.4 Comply with safety requirements in commissioning.
LO4 Know the scope of work of the third stage of setup	4.1 Perform the work of the third stage of adjustment under the guidance of a service engineer. 4.2 Comply with safety regulations and labor protection when performing adjustment work on the existing technological equipment.

PM.06 «Computation of automated systems»

Aims and objectives

The aim of study of this module is to provide training of learners in the field of analysis, calculation of the automatic regulation systems and research of compliance of the system with specified technological requirements.

Introduction into module

This module gives learners an understanding of the purpose, structure of the automatic regulation systems, methods of their construction, methods of analysis, calculation and study of behavior of automatic systems, their components and measurement circuits.

The automatic regulation systems represent a set of an object and automatic regulator. There is given a concept of an object of regulation, its static and dynamic characteristics, there is made an analyze of disturbances affecting the object, delays of the object. There is discussed the need for and the possibility of control and regulation of technological parameters of the object of regulation; selection of control and regulation channels; ways of getting information about a regulated parameter; basic types and principles of measuring devices, calculation of electric circuits with their use, analysis of their electronic schemes; ways to achieve the required measuring accuracy and reliability, based on metrological standards; measurement techniques, analysis techniques of measurement results. There is introduced the concept of a signal as a means of information transmission. There are considered types of signals and their characteristics, natural and unified signals. There are studied measurement techniques for various technological parameters. There are considered basics of construction and operation of measuring signals transducers and their characteristics, inclusion schemes for signals transducers into measuring circuits, general characteristics of signal transducers as elements of automatic regulation systems. There are studied principles of construction, operation and nomenclature of produced by industry electric and pneumatic regulators, position regulators and continuous action regulators, direct-action regulators, electrical, pneumatic, hydraulic actuators and different types of regulators.

The module gives learners the basic concepts and definitions of closed-loop and open-loop automatic regulation systems, functional elements of the system, their positions and roles. Using the theoretical content of the module, learners can record transfer functions of elementary units of the automatic regulation system, transfer functions of the regulation system on the basis of their dynamic characteristics. The module provides a classification of typical regulators Proportional (P), Integral (I), Proportional-integral (PI), Proportional-integral-differential (PID), discusses their practical application, advantages and disadvantages, selection of regulatory law, the finding of transfer functions of the regulation system upon a given structural scheme and known expressions of transfer functions of the links and regulator, calculation of setup parameters for the regulator, determination of the quality of regulation, investigation of stability of the regulation system.

The module is suitable for training of future professionals in the field of commissioning, service and maintenance of measuring devices, measurement systems and control systems.

During studying the module leaners will receive practical skills of selection of measuring devices, their calibration, setup to minimize measurement errors, kitting instruments for measuring parameters, measured data processing, selection of automation means into the automatic regulation system, analysis of static and dynamic characteristics of components and systems, setup of configuration regulators and regulation loops, design of automatic regulation systems.

The module is based on practical skills obtained during practical and laboratory works, educational practices, and practices at the enterprise.

Learning outcomes

Upon completion of this module, leaners should:

1. Know basics of the theory on the automatic regulation system, basics of construction, calculation and analysis of the automatic regulation system.
2. Know basics of metrology and measurement techniques of electrical and non-electrical values; analysis techniques of measurement results.
3. Know main types and operating principles of devices for measurement systems.
4. To be able to complete devices for measuring technological parameters, to know device interface methods into kits and calculation methods of measuring circuits.
5. To understand the purpose of automation tools used in construction of automatic regulation systems, to know the types and nomenclature of produced by industry automation tools.

Module content

1. To know basics of the theory on the automatic regulation system, basics of construction, calculation and analysis of the automatic regulation systems

The classification of the object of regulation: linear and nonlinear, static and astatic, continuous and discrete. The disturbances affecting the object of regulation: external and internal, continuous and periodic, measured and unmeasured. Objects with delay and without delay. Static and dynamic characteristics of the object of regulation, the acceleration curve. Input and output signals of the object of regulation. Description of dynamic properties of the object by a differential equation, determining the order of a differential equation. Laplace Transformation. Understanding of the transfer function. Closed-loop and open-loop automatic regulation system. Components of the automatic regulation system: the automatic regulator and object of regulation. Functional block diagram of the closed-loop automatic regulation system, its components: set point device, adding device, regulator device, actuating mechanism, regulator, sensor.

The concept of typical dynamic links and their properties, main indicators and characteristics. The concept of frequency response: amplitude-frequency, phase-frequency, amplitude-phase, logarithmic. Hodograph. The frequency response of dynamic links. Typical regulatory laws: Proportional (P), integral (I), a proportional-integral (PI), proportional-integral-differential (PID), their advantages and disadvantages, the transfer functions into the regulation system, selection of regulatory law in to automatic regulation system. Calculation of setting parameters of the regulator. The transfer function of the closed-loop and open-loop automatic

regulation system. Characteristic equation. The frequency response of automatic regulation systems. Direct and indirect quality assessments of the regulation. The concept of stability of linear regulation systems. Sustainability criteria of Hurwitz, Mikhailov, Nyquist.

2. To know basics of metrology and measurement techniques of electrical and non-electrical values; analysis techniques of measurement results

Basic concepts and definitions of metrology, its tasks. The concept of a signal as a means of information transmission. The physical nature of a signal. Units and lettering of measured values. Methods for obtaining information on the measured parameter. Measurement techniques of signals, the concept of a primary measuring transducer (sensor), the concept of a measuring device. Electrical measuring circuits. Ways to achieve the required accuracy of measurement and reliability based metrology standards, methods of analysis of measurement results. Measuring tools and their basic metrological characteristics. Types of errors - dynamic and static, absolute, relative, reduced.

3. To know main types and operating principles of devices for measurement systems

The main types, basics of construction, principles of operation and characteristics, inclusion schemes for measuring signals transducers into measuring circuits, power supply and types of energy for measuring transducers. Calculation of electrical measuring circuits, analysis of electronic schemes for measuring tools and measuring circuits. Power supply schemes for measuring transducers, analysis, compilation and calculation. Electric meters and electrical measurements. Expansion thermometers, resistance thermal transducers, thermal electric transducers, thermistors, pyrometers. Pressure measuring and pressure drop devices, liquid, spring, membrane, sylphon, deformation.

Measuring tools of the amount and consumption of substance by variable-pressure drop method, inductive flowmeters and tachometric counters, and volumetric flowmeters. Hydrostatic, float, buoy, acoustic, ultrasonic, capacitive, Level waveguide. Measuring devices for physico-chemical properties of substances: moisture and air, solid and bulk substances, air dust concentration, measuring devices for density, viscosity, electrical conductivity of liquid media, chemical composition and concentration. Nonindicating devices and methods for displaying measurement information: analog reading indicating and recording secondary devices, digital indicating devices and data indicating systems. Variable-resistance sensors:. rheostat, carbonic, tensometric and other. Electromagnetic sensors of linear and angular movement: inductive, transformer. Piezoelectric, magnetoelastic sensors.

4. To be able to complete devices for measuring technological parameters, to know device interface methods into kits and calculation methods of measuring circuits

Types of signals: electrical, pneumatic, hydraulic, continuous and discrete, pulse, natural and uniform, their parameters, and size of changing and measurement, modes of transmission, storage, display, visualization. Remote signal transmission. Understanding signal transducers: primary, measuring, transmitting, normalizing,

power stabilizer, transformer, rectifier, filter, multiplier, comparator, inverter, frequency transducer, analog-to-digital transducer, digital-to-analog transducer.

Selection of primary measuring transducer to measure various physical values. Device interface methods with electrical signals and calculation methods of coupling circuits. Basic laws of electrical circuits for AC and DC.

Electromagnetic circuits and transducers. Completion of devices sensor – secondary device, sensor - measuring transducer, sensor - normalizing transducer. Understanding functions coincidence for reception, conversion and display of measurement information in a single device. Selection out of the possible complete sets of optimal upon techno-economic indicators in accordance with the required metrological characteristics.

Determination of location of measuring devices and display on shield and technological object (at place).

5. To understand the purpose of automation tools used in construction of automatic regulation systems, to know the types and nomenclature of produced by industry automation tools.

Sensors and signal transmitters (relays) of technological parameters. Regulators: positional, direct action, analog, relay, digital (microprocessor). Methods for setting regulated parameters: physical, software.

Actuators (actuating mechanism): electrical, pneumatic, hydraulic; AC and DC; synchronous and asynchronous servo-actuators, stepper motors, their structure and working principles. Relays and starters: solid-state and electromagnetic.

Equipment for control and protection: control circuits switches, push-button stations, switches, circuit breakers, automatic circuit breakers, fuses, thermal relay. Signal elements of light and sound signaling systems.

Training outcomes and assessment criteria

Training outcomes **After successful completion of this module the leaner should:**	**Assessment criteria** **The leaner should:**
RS1 Know basics of automatic regulation theory, basics of construction, calculation and analysis of automatic regulation systems.	1.1 Give a description of the object of regulation, list disturbances affecting the object. 1.2 Explain receipt of the acceleration curve of the object by an experimental approach. 1.3 Record the transfer function of the object and determine the transmission coefficient of the object, time constant and delay according to the acceleration curve. 1.4 Explain general characteristics of elements of automated systems, record their transfer functions. 1.5 Construct link and systems frequency response. 1.6 Develop functional block diagram of the automatic regulation system. 1. 7 Select a regulator to the regulation system. Produce comparative characteristics of different types of regulators. 1.8 Calculate regulator settings. 1.9 Assess quality of regulation. 1.10 Analyze the closed-loop regulation system for stability. 1.11 Apply gained knowledge on calculation of regulation systems in the development of control circuits and regulation of process parameters.
RS2 Know basics of metrology and measurement techniques of electrical and non-electrical values; analysis techniques of measurement results.	2.1 Assess metrological characteristics of measuring devices when selecting measurement parameters and values. 2.2 Understand working principles of measuring devices for electrical and non-electrical values, their purpose and practical application. 2.3 Perform measurement techniques, analysis techniques of measurement results. 2.4 Determine the most significant value of measured values. 2.5 Determine absolute static, relative, and reduced error.

RS3 Know main types and operating principles of devices for measurement systems.	3.1 Select primary measuring transducer for measurement of a physical value. 3.2 Put measuring devices into operation. 3.3 Red off and analyze static characteristics of measuring transducers. 3.4 Make setting of devices.
RS4 Be able to complete devices for measuring technological parameters, to know device interface methods into kits and calculation methods of measuring circuits.	4.1 Exercise selection of a set of devices for measurement. 4.2 Explain device interface measurement circuit. 4.3 1 Exercise selection of power supply resource for measuring scheme. 4.4 Calculate measuring scheme and a circuit device connecting circuit. 4.Take into account while selection of devices into the set their location on the object and on the shield. 4.6 Make setting of secondary devices.. 4.7 Use visualization tools to display measurement results.
RS5 Understand the purpose of automation tools used in construction of automatic regulation systems, to know the types and nomenclature of produced by industry automation tools.	5.1 Select sensors depending on required output parameters. 5.2 Select regulators to required type of the regulating signal. 5.3 Explain required setting of a parameter depending on the type of regulator. 5.4 Explain use of the type of actuator to the regulation system. 5.5 Know characteristics and working principles of actuators. 5.6 Explain the purpose and working principles of relays and starters, exercise their selection into the regulation system. 5.7 Use control and protection equipment in actuator control circuits.

PM.07 «Planning and work organization, assessment of the results»

Aims and objectives

This module introduces leaners to the basic principles of rational arrangement of the production structure of an enterprise, methods of management and planning operation for a primary labor collective – of a site, brigade.

Introduction into module

The enterprise is a complete economic system, consisting of separate structural subdivisions, ensuring development of this system. The modern enterprise includes a set of production subdivisions (workshops, sites), control organs and organizations on service of employees of the enterprise.

The composition of structural subdivisions of the enterprise, their number, size and the ratio between the size of production areas, the number of personnel and capacity characterize the general structure of the enterprise. The first part of the module will introduce leaners to the basic elements of the production structure of the enterprise, organizational principles of the production process, areas of work organization in the workplace.

Planning operation of auxiliary services of the enterprise (power utilities, instrumentation and control equipment (ICE) service) is based on a system of scheduled preventive maintenance. One of the conditions for efficient operation of any enterprise is the presence of a well-functioning mechanism for repair works. The lower the proportion of the cost of repairs, maintenance and upkeeping of equipment in the production primecosts are, the higher the efficiency of the enterprise is. The second part of the module should introduce leaners to the basic concepts of the system of scheduled preventive maintenance, teach them to use the system standards for planning operation of a production site or service, to use regulatory reference literature.

In the final part of the module leaners should get acquainted with arrangement of labor rating in the workplace, main methods of labor rating, methods of studying work time expenditures, as well as modern forms of labor remuneration.

Learning outcomes

Upon completion of this module, leaners should:

1. Know basic principles for arrangement of a production structure of the enterprise.
2. Be able to make up a scheduled plan for repair, maintenance, adjustment.
3. Be able to calculate the rate of time and service.
4. Know methods of calculating labor remuneration for different forms and systems. To be able to distribute salaries in a brigade using labor participation coefficient (LPC).

Module content

1. To know basic principles for arrangement of a production structure of the enterprise.

Under a production structure of the enterprise there is understood the composition of its constituent sites, workshops and services, forms of their interrelations in the process of output of products. The main elements of a production structure

of the enterprise are considered workplaces, sites, workshops. Final results of the enterprise operation essentially depend on the level of organization of workplaces, reasonable determination of their number and specialization, coordination of their work in time, rationality of their location in the production area. It is on the level of the workplace the main factors of growth of labor productivity are used. The workplaces are combined into sites.

Production sites specialize by details and technologically. A foreman manages the production site. Sites, interconnected by constant technological links, unite into workshops. A workshop is endowed with certain production and economic independence. Each workshop receives from the management of the plant a single target figure, which regulates the amount of work performed, quality indicators and marginal costs of the planned scope of work.

The production process is a set of separate labor processes aimed at transforming raw materials into finished products with a given quantity, quality and variety, and within the established deadlines.

2. To be able to make up a scheduled plan for repair, maintenance, adjustment.

Perfection of the production structure is one of the factors of improvement of the enterprise operation. The main objective of the maintenance facility operation is to ensure uninterrupted operation of the equipment, including automation means. Maintenance facility services in the enterprise management system subordinate to the chief engineer.

The system of scheduled preventive maintenance is a set of various types of works on technical maintenance and repair of the equipment, carried out on a predetermined plan to ensure the most efficient operation of the equipment.

To calculate needs in staff leaners will get acquainted with a calculation methodology of the working time balance, determine the nominal and effective working time funds. Recruiting staff is the minimum necessary number of employees who have to come to work every day to complete the task on time. Payroll staff is all permanent and temporary employees registered on the company, as the currently running job and being in the next vacation, business trip, do not appear to work due to illness or other reasons.

3. To be able to calculate the rate of time and service

For labor rating common standards and unified (typical) norms are used. At the enterprises there are calculated and established norms of time, production, service, manageability as well as normalized targets. For auxiliary workers there are used norms of time, service, normalized targets.

Labor rating methods: experimental-statistical and analytical. To the main methods of studying working time costs for under the analytical method there are attributed: time tracking, time recording sheet, photo time tracking. The result of the time tracking and time recording sheet is establishment of labor standards and the development of measures for elimination of working time losses, strengthening of labor discipline.

4. To know methods of calculating labor remuneration for different forms and systems. To be able to distribute salaries in a brigade using labor partici-

pation coefficient (LPC).

A system of labor financial stimulation includes salary, cash bonuses. Sometimes, as a tool of financial stimulation there is used a system of employee participation in the profits of the enterprise. The salary is an employee's remuneration for the final result of his labor. Salary functions: reproductive, stimulating, social.

The enterprise tariff system is a set of norms and standards that provide differentiation of labor remuneration depending on the complexity, intensity and working conditions. Elements of the tariff system are:

- tariff classification manuals;
- tariff rates of 1 category;
- tariff scales;
- bonuses and allowances for deviations from normal working conditions.

Main forms of labor remuneration: piecework and time-based.

When tariffless labor remuneration system an employee's salary represents his share in the payroll budget that is constructed according to the results of the enterprise operation. This system is quite effective in a market economy.

Training outcomes and assessment criteria

Training outcomes **After successful completion of this module the leaner should:**	**Assessment criteria** **The leaner should:**
RS1 Know basic principles for arrangement of a production structure of the enterprise.	1.1 Determine elements and principles of arrangement of the production structure and production process. 1.2 Explain impact of external and internal factors on the production structure and production process. 1.3 Be able to depict graphically an example of rational arrangement of the production structure.
RS2 Be able to make up a scheduled plan for repair, maintenance, adjustment.	2.1 Know basic standards of the system of scheduled preventive maintenance. 2.2 Be able to make up a scheduled plan of works, to calculate labor intensity and staff number. 2.3 Be able to use the normative-reference literature to the system of scheduled preventive maintenance.
RS3 Be able to calculate the rate of time and service.	3.1 Be able to carry out the time tracking and time recording sheet 3.2 Be able to calculate time standards for maintenance and repair of devices
RS4 Know methods of calculating labor remuneration for different forms and systems. To be able to distribute salaries in a brigade using labor participation coefficient (LPC).	4.1 Be able to calculate labor remuneration in different forms and systems 4.2 Be able to calculate labor participation coefficient (LPC).

PM.08 «Design of microprocessor systems of automated control»

Aims and objectives

The aim of studying this module is to develop the leaner's knowledge, abilities and skills on the basics of design of automated industrial process control systems based on programmable logic controllers (PLCs).

Introduction into module

This module gives leaners an understanding of tasks and design technology of automated microprocessor systems and complexes.

Modern industrial process and production control systems are arranged in a hierarchical manner, where each level of the control system is in subordination to a higher level. This arrangement has become relevant and possible in connection with the development of a computer microprocessor technology and software. The hierarchical arrangement of automation industrial process control systems (AIP CS) requires the use of programmable logic controllers, control program development, information transmission tools between the levels of the control system, visualization, data archiving, and others.

The module considers arrangement of industrial process distributed control systems (DCS), in which functions of collecting, processing, managing and calculating are distributed between industrial controllers of the low level, responsible for control of their sites; there are discussed types of industrial networks and interfaces involved in the information transmission between elements of the system, their parameters, and their implementation.

The module contains information on industrial programmable controllers, which is used for training of qualified specialists in the field of maintenance and operation of distributed control systems, on information transmission networks between the elements of the control system.

The module gives practical skills in drawing block diagrams of distributed control systems based on an analysis of its required technical and economic characteristics. The leaner gets the experience of taking decisions on arrangement of control systems using programmable logic controllers (PLCs), preparation and execution of the project documentation for implementation of distributed control systems, including functional circuits of automation, electrical basic schemes for control, regulation, signaling, electrical actuators and pneumatic control, electrical basic supply schemes, installation diagrams and drawings of general types of boards and panels, external connection diagrams of electric wiring and piping.

The module is based on the use of skills of graphic editors AutoCAD and / or COMPASS, and the Microsoft Office suite for the production of project documentation, obtained when studying the module "Design of control and automation systems," and the passage of training and production practices.

The module is used for training of specialists engaged in the development, maintenance and operation of distributed control systems for continuous, cyclical and continuous, cyclical process in metallurgy, electric power and other industries.

Learning outcomes

Upon completion of this module, leaners should:

1. Know the architecture of distributed control systems, methods of its arrangement.

2. Understand the information transmission and processing in the control system, know the software, technical information transmission tools between the system elements, their characteristics.

3. Know the applicability, principles of arrangement and technical characteristics of a programmable logic controller (PLC) and other elements of the microprocessor-based control system.

4. Know the stages of development, packaging and execution of project documentation used for installation, adjustment, maintenance and operation of the industrial process distributed control systems.

Module content

1. To know the architecture of distributed control systems, methods of its arrangement

The controller work with a group of input-output devices to service a particular part of the object of control. Implementation of decentralized control on the lower level of the control system. The structure of the distributed control system similar to the structure of the object of control. Consideration of the distributed control system as a system consisting of a plurality of devices spaced apart, each of which is independent of the others, but interacts with them to perform common tasks.

The connection between the elements of the control system via the Internet for remote location of the objects from each other. The connection via the Internet between the programmable logic controllers included into the control system. Distributed control functions in the automation system.

Advantages of the distributed control system with respect to concentrated: larger speed performance thanks to distribution of tasks between the parallel running processes; increased reliability - failure of one controller does not affect the work of others; larger failure tolerance; more simplified increment or reconfiguration of the system; more simplified system upgrade; greater simplicity of design, adjustment, diagnostics and maintenance; improved noise immunity and accuracy by reducing the length of the analog signals transmission lines from the sensors to the input devices. Hardware and software redundancy in the control systems using PLC.

2. To understand the information transmission and processing in the control system, know the software, technical information transmission tools between the system elements, their characteristics.

Methods for description of distributed systems for their efficient design. Compatibility and interchangeability of devices in the system. The International Standard IEC 61499 “Functional blocks for industrial control systems.” Three levels of hierarchy of models in the development of the distributed systems: the system model, the physical devices model and the function blocks model. The information transmission and processing in the system.

Event-driven control. Using functional blocks for maintenance of the control system lifecycle: design, manufacture, operation, validation and maintenance. The distributed system model: a set of physical devices and industrial networks. The system architecture with a common bus.

Industrial networks and interfaces: Fieldbus, Profibus, Modbus, DeviceNet, CANopen, Foundation, Industrial Ethernet, Internet and other. The difference between industrial networks from office networks. Network interfaces, interface parameters: throughput capability and the maximum cable length. Serial interfaces:RS-485, RS-232, RS-422, Ethernet, CAN, HART, AS-interface. Information exchange protocols. Information transmission in the network via the channel.

Transmission media: twisted-pair cables, optical fiber, environment. Types of data in distributed networks: signals, commands, status, event, query. Network topology: star, ring, bus, mixed. Network performance: response time and throughput capability. The reliability of data delivery by the network. network security, resiliency, interference immunity, probability of data delivery.

3. To know the applicability, principles of arrangement and technical characteristics of a programmable logic controller (PLC) and other elements of the microprocessor-based control system.

Commercially available components used in arrangement of distributed control systems: the programmable logic controller (PLC), input-output modules, sensors, executive actuators. Monoblock and modular PLC. Nomenclature of controllers: Siemens, Mitsubishi, Advantech, ABB, Schneider Electric, GE Fanuc, Scientific-Research Laboratory of Design Automation (SRL DA), Tecon, Fastwel, DEP, Oven, Elemer, Emicon and other. Functional characteristics of the controller, specifications (temperature range, reliability, manufacturer's brand, availability of certification on the territory of the Republic of Kazakhstan). Modular controllers, module types. Module of the central processing unit (CPU), its constituent parts: a microprocessor, memorizing device

Microprocessor key features: type of operating system (Windows CE, Linux, DOS, OS-9, QNX and other.); availability of the executive environment for a standard programming system in languages IEC 61131-3; types of supported interfaces (RS-232, RS-422, RS-485, CAN, USB, Ethernet and other.); types of supported networks (Modbus RTU, Modbus TCP, Ethernet, Profibus, CANopen, DeviceNet and other.); ability to connect indicating devices or operator interface (LED or LCD display, keyboard, mouse, display with interfaces VGA, DVI or CMOS, LVDS, trackball and other.); bitness (8, 16, 32 or 64 bits); microprocessor and memory clock speed; runtime for commands; volume, hierarchy and types of memory; types of built-in functions (PID regulator, counters, PWM, positioning and motion control algorithms, etc.).

Types of memory storage: ROM – Read Only Memory, EEPROM - Electrically Erasable Programmable ROM, flash-memory – Compact Flash (CF), Memory Stick, Secure Digital (SD), MuliMediaCard (MMC), RS-MMC, SmartMedia Card (SMC), USB-flash; SRAM – Static Random Access Memory, DRAM – Dynamic Random Access Memory, SDRAM – Synchronous DRAM.

Modules as part of PLC: signaling modules, functional modules, communication modules, modules, power supply resource modules, etc.

Parallel data exchange buses with IO modules (ISA, PC/104, PCI, ComactPCI, VME, CXM).

Serial controller bus (based on RS-485 interface) for connecting distributed IO modules.

4. To know the stages of development, packaging and execution of project

documentation used for installation, adjustment, maintenance and operation of the industrial process distributed control systems.

Stages of the AIP CS development and design level: feasibility study, technical specifications, technical project (or working documentation), experimental implementation, industrial exploitation.

Normative documentation defining general requirements, the order of development, the composition of the project documentation and the procedure for its compilation. Initial data for design. Structural schemes of the industrial process distributed control systems. Means of obtaining information about the course of the process and the information transmission tools to PLC.

Functional scheme of automation, electrical basic schemes for control, regulation, signaling, electrical actuators and pneumatic control, electrical basic supply schemes, installation diagrams and drawings of general types of boards and panels, external connection diagrams of electric wiring and piping.

Technical and software tools for the development of texts and drawings for the automation project, automated design system (ADS).

Training outcomes and assessment criteria

Training outcomes After successful completion of this module the leaner should:	**Assessment criteria The leaner should:**
LO1 Know the architecture of distributed control systems, methods of its arrangement.	1.1 Orientate in the PLC technical documentation. 1.2 Be familiar with terminology that appears in the literature. 1.3 Know the PLC types, their technical characteristics, applicability in real control systems. 1.4 When designing control systems, use the connection between elements of the control system via the Internet. 1.5 Design control systems with hardware and software redundancy.
LO2 Understand the information transmission and processing in the control system, know the software, technical information transmission tools between the system elements, their characteristics.	2.1 Use standard methods for describing the distributed systems for their efficient design. 2.2 Be able to explain the information transmission and processing in the system. 2.3 Create a model of distributed systems using a set of physical devices and industrial networks. 2.4 Know the industrial networks and interfaces, communication protocols. 2.5 Select information transmission media: twisted-pair cables, optical fiber, environment. 2.6 Use knowledge of topology and technical characteristics of the industrial networks for network development of trouble-free, reliable, high speed data transmission systems.

LO3 Know the applicability, principles of arrangement and technical characteristics of a programmable logic controller (PLC) and other elements of the microprocessor-based control system..	3.1 Know nomenclature of PLCs and automation devices manufactured on an industrial basis, major manufacturers. 3.2 Be able to describe the CPU main technical parameters to the PLC. 3.3 Know possibilities of the monoblock PLC and functional possibilities of the modular PCL, their modular structure. 3.4 Know the parallel and serial data exchange buses. 3.5 Explain applicability of the parallel data exchange buses. 3.6 Explain applicability of the serial data exchange buses.
LO4 Know the stages of development, packaging and execution of project documentation used for installation, adjustment, maintenance and operation of the industrial process distributed control systems.	4.1 Describe the essence of stages of development of the microprocessor-based control systems. 4.2 Use normative documentation in the development of the project documentation for control systems. 4.3 Develop block diagrams of the industrial process distributed control systems. 4.4 Select means of obtaining information on the course of the process and means to communicate this information to the programmable logic controller (PLC). 4.5 Possess skills of development of functional circuits of automation based on use of PCL. 4.6 Develop basic, installation diagrams for the automation project using PCL. 4.7 Execute the project documentation, using graphic and text editors, computer-aided tools. 4.8 Use of ADS in development of the automation project.

PM.09 «Programming of microprocessor instruments of APCS (Automatic process control system)»

Aims and objectives

The purpose of studying this module is to provide training of leaners engaged in the development and operation of high-performance and highly reliable control systems based on programmable logic controllers (PLC) and dispatch control systems and data acquisition systems Supervisory Control And Data Acquisition (SCADA).

Introduction into module

This module will give leaners an understanding of programming techniques for microprocessor tools, used as a part of modern automation systems. The automation systems that are based on microprocessor technology, and regulators implemented on the basis of this equipment, are called digital.

The module consists of lectures, practical classes and laboratory practices. It is based on skills acquired in the course of engineering practice.

The module considers digital control systems, which are commonly used to monitor and control a variety of technological processes. The "brain" of a digital control system is a programmable logic controller with an embedded operating system. Digital control systems increase the degree of industrial automation, which in turn sets the task of redistribution of functions between a human operator (dispatcher) and the control system. The solution of this problem is the SCADA-system, sometimes referred to as the SCADA / HMI, which is focused on dispatching tasks. The SCADA-systems are well applicable for continuous and distributed process automation control. The SCADA-systems are used in the industrial automation level, which is connected to data acquisition from various sensors and input-output devices, visualization of the collected information and archiving.

The module provides an understanding of the control program for the industrial process control system, prestored in the memory of the industrial controller with an embedded operating system. There is considered a possibility of use of traditional software tools (languages C, Pascal, etc.), complexity of writing programs with their use and limitations of their application. There is given an understanding of specialized language resources, their independence from the computer platform.

The module will allow leaners to apply special platform-independent programming languages fro controllers for the purpose of writing control programs for various PLC types.

During studying the module leaners will receive practical skills to use SCADA in the industrial process dispatcher control, to draw up mimic diagrams for visualization of processes and system operation, to write control programs, to develop and test software applications for PLC, to create functional block libraries, to adjust programs without connecting to the real PLC, to use emulators to simulate signals of the input-output modules.

The module is used for preparation of professionals involved in the development of control programs for industrial controllers as part of the automated process control systems and carrying out their despatching.

Learning outcomes

Upon completion of this module, leaners should:

1. Know types of microprocessor tools, their structure and use in control systems.
2. Understand the logical structure of microprocessor-based AIP CS, the need of software supply for its operation.
3. Know the use of SCADA-systems in the industrial process dispatcher control.
4. Apply platform-independent languages for programming of controllers for various PLC types.

Module content

1. To know the types of microprocessors, their structure and use in control systems

The concept of microprocessor devices. The evolution of microprocessor devices. Classification of microprocessors. Structure and types of microprocessor devices. Characteristic features of microprocessor-based devices for technological process automation. Principles of standard components and circuits of electronic devices and components of microprocessor technology. CMOS-technologies (Complementary Metal Oxide Semiconductor), p-channel (PMOS) and n-channel (NMOS) MOS-transistors. SSI, MSI, LSI. ADC and DAC, PWM, PIT, a register, a counter, serial interface SCI and SPI, LCD, RAM, ROM, EEPROM, CPU module and others.

Operating conditions and scope of industrial electronics. Microprocessors, microcontrollers, single board computers, industrial computers, and industrial controllers: features, applications, applications for building control systems. Microprocessors Architecture.

Microprocessor-based programming. The concepts of modularity, Mining and micro programmable microprocessor systems.

2. To understand the logical structure of microprocessor-based automation systems, TP (Technological Processes), the need for software for its functioning

Structural and schematic diagrams of microprocessor systems. Hardware microprocessor systems: PLC, PLC modular structure, PLC means and interface circuit with service facilities, a database server, and workstation operator (AWP). Software of microprocessor systems: a series of commands, programme, and a set of tools support the information programmes, the algorithm operation of microprocessor systems. Principles of the organization of computer control systems are based on programmable logic controllers. Hierarchy Method.

3. To know the use of SCADA-systems in the dispatching process control

General concepts and structure of SCADA-systems: definition and general structure of SCADA, SCADA functional structure, especially as the process control SCADA (Supervisory Control and Data Acquisition - Supervisory Control and Data Acquisition). Basic requirements for SCADA-systems and their capabilities. Hardware and software for SCADA-systems: the basic requirements for SCADA-systems, the main features of modern SCADA-packages, trends in the development of hardware and software SCADA-systems.

SCADA-products in the industrial market: In Touch (Wonderware, USA), iFIX

(Intellution, USA), SIMATIC WinCC (Siemens, Germany), Citect (Ci technologies, Australia), RTAP / plus (HP, Canada), Wizcon (PC Soft International, Israel-US), Sitex and Phocus (Jade SoftWare, UK), Real Flex (BJ Software Systems , USA), Factory Link (US Data Corp. , USA), View Star 750 (AEG, Germany), PlantScape (SCAN 3000) (Honeywell's, United States), TRACE MODE (AdAstra, Moscow), SCAT (Centreprogrammesystem, Tver), Sargon (NRT-Automation), VNS, GARDEN, Vis-a-Vis (INSAT), VIORD («fjord») , RTWin (SWD - Real Time systems), pROBE (PCS programme).

4. Apply platform-independent programming languages controllers for different PLC types

International Electrotechnical Commission (IEC / IEC), IEC 1131-3 standard. Five specified PLC programming languages: three graphic (SFC, FBD, LD) and two text (ST, IL). The methodology of structured programming . Visual programming language FBD and IL: elementary and library functions, built-in algorithms - PID, traffic rules, algorithms of adaptive and modal controllers, fuzzy, position control, dynamic balancing, queuing algorithms, blocks of objects modelling , arithmetic, algebraic, trigonometric, statistical functions, function calculation of technical and economic indicators, etc. Functional blocks for control and model control of technological objects (valve, valve, actuator, etc.).

Learning outcomes and assessment criteria

Learning outcomes After successful completion of this module the learner	**Criteria for evaluation The learner must**
LO1 To know types of microprocessor means, their structure and use in control systems.	1.1 Navigate through the literature on microprocessors and microcomputers. 1.2 Possess the terminology that appears in the literature. 1.3 To know the electronic components of microprocessor devices. 1.4 To be able to choose one or the other set of the microprocessor for use in a particular system. 1.5 Own the basics of programming microprocessor systems. 1.6 Programming a type of microcontroller for solving elementary logic situations. 1.7 Be able to programme one of the most common sets of microprocessor. 1.8 To know the complete set of personal and / or industrial PC used in practical programming of microprocessor systems. 1.9 Choosing the microprocessor unit in an automation system in accordance with the required functions.

LO2 understand the logical structure of the microprocessor-based automation systems, the need for software for its operation.	2.1 To prepare the structural scheme of the automated systems using microprocessor devices. 2 .2 To be able to navigate in the service of microprocessor-based automation systems. 2 .3 Explain the principles of the organization of computer control systems based on programmable logic controllers 2 .4 Apply the principle of hierarchy in programming microprocessor APCS
LO3 To know the use of SCADA-systems in the dispatching process control.	3 .1 explains the SCADA-systems, their capabilities. 3 .2 Identify the basic requirements for SCADA-systems at a choice of the automation system. 3 .3 Select SCADA automation system for technical and economic indicators. 3 .4 Use one of the SCADA-systems in the preparation of the graphical interface of industrial automation systems.
LO4 Apply platform-independent programming languages controllers for various PLC types.	4 .1 Describe the characteristics and applicability of software in automation systems. 4 .2 Select programming technology, the main components. 4 .3 Demonstrate To know ledge of algorithmic programming languages. 4 .4 Arrange specified PLC programming languages, explaining their relevance. 5.4 Use visual language FBD programming in the programming of a PLC type. 4 .6 Perform software debugging. 4 .7 The use of computer technology to process text and graphic documents on the development and use of software ACS.

PM.10 "Calculation of economic efficiency of automation project implementation"

The purpose and task

This module introduces students to the concept, structure, funding sources and investment principles of the investment policy of the enterprise. Students must learn techniques and methods for design analysis.

Introducing module

Investment activity of the enterprise is an important part of its overall economic activity capital intensity and the increased of modern production role long-term factors are constantly growing.

In order to make enterprises operate successfully, improve product quality, reduce costs, expand production capacity, improve competitiveness of their products and to strengthen its position in the market, it must invest, and invest it profitably. Therefore, it is necessary to carefully develop the investment strategy and constantly improve it in order to achieve the above objectives.

In the first part of the module students will learn the concept of investment and, above all, in the fixed capital - capital investments. Just study the classification and structure capital-forming investments, sources of financing.

In the second part of the module examines the factors influencing the efficiency of investment, both at the regional level and at the level of individual enterprises, and study the methodology for determining the efficiency of investment.

In the final part of the module students will learn the technique of an economic substantiation of automation projects.

Learning outcomes

Upon completion of this module, students should:

1. To know the content and direction of the investment policy of the enterprise.
2. To know the factors affecting the efficiency of investments; sources of their financing.
3. To be able to carry out a feasibility study for projects of automation of technological processes.

Module content

1. To know the content and direction of the investment policy of the enterprise.

Investment - is the implementation of specific economic projects in this with the expectation to receive income in the future. Investments can be divided into portfolio and real. Portfolio (financial) investments are investments in stocks, bonds, and other securities. Real investment is called capital investments. In this case, the enterprise - investor, investing, capital increases its production - basic production assets and necessary for their operation working capital.

Capital investments are classified according to several criteria:

a) Forms of reproduction of fixed assets:

- For new construction;
- The expansion and modernization of existing enterprises;
- For the modernization of equipment;

- For major repairs

b) Sources of funding - at centralized and decentralized

c) In the direction of use - for production and non-production

g) The period of the investment - long-term and short-term.

Significant impact on the efficiency of capital investments has their technological structure. Technological structure of capital investments is part of the costs for the construction of an object, and their share of the estimated cost. That is, this structure shows the proportion of capital investments in their total value is directed to the construction and installation works, the purchase of equipment for the design and development and other costs. Improvement of the structure is to increase the share of machinery and equipment in the estimated cost of the project to the optimum level.

The investment policy of the enterprise should be planned so as to obtain maximum benefit from both portfolio and direct investments with minimal investment risk.

2. To know the factors affecting the efficiency of investments; sources of funding

The investment process is a complex multi-faceted process that is influenced by many factors. To know ledge of these factors, the mechanism of their influence on the efficiency of investments is a sound basis for the development of the investment policy of the enterprise.

Factors affecting the efficiency of investments at the enterprise level are:

- Effectiveness of the enterprise economic and social policy;
- The quality and competitiveness of products;
- The level of use of fixed assets;
- The quality and efficiency of implemented investment projects, and other factors.

Depending on the orientation of the impact all factors can be grouped:

- Positive, with positive effects on the efficiency of investment (lower inflation, the refinancing rate of the National Bank of Kazakhstan, and others.)
- Negative, which adversely affect the efficiency of investment (the aggravation of the economic crisis, increased inflation etc.)

It is important that the investment activity in the country governed by laws that have long-term character.

Identifying sources of financing has always been one of the most important problems in the investment activity.

Capital expenditures can be financed by:

- Own funds (profit, depreciation);
- Borrowed funds (bank loans, bonds and others.);
- Attracted financial means of investor (the sale of stocks, shares, etc.).

Financing of investment projects can be carried out by the state through targeted programmes, such as the so-called “breakthrough” high-tech projects.

3. To be able to carry out a feasibility study for projects of automation of technological processes

Before the implementation of the investment project, you must make it a feasibility study. It must give an account of the profitability or otherwise of the implementation of investment projects. With the most reliable and proven methodological approaches that will reduce the investment risk to a minimum must be used.

For the feasibility study of investments is necessary to use an official document - "Guidelines for assessing the effectiveness of investment projects" approved by the Ministry of National Economy of Kazakhstan, the Ministry of Construction of the RK and housing and communal services.

It should be noted that the basis of the recommendations laid down in the world proven methodological approaches, which testifies to their objectivity.

Indicators used in this procedure:

1) Net present value (NPV) - NPV

2) Profitability index (ID) - PI

3) Internal Rate of Return (IRR) - IRR

4) Payback period ($T_{c)}$ - PP

The value of the net present value:

Where:

R_{t} is the results (all cash inflows), achieved by the step of the calculation;

W_{t} is the costs (all cash outflows, excluding capital investments), implemented on the same step;

T is the calculation horizon (month, quarter, and year);

E is the discount rate;

K is the capital expenditure necessary for the implementation of new technology

$_{R}t - H_{t} = Ac_{t} + A_{t,}$

Where:

Ac_{t} is the net profit;

A_{t} is depreciation.

Rule: If - the project is profitable,

If - the project is not profitable,

If - the project is neither profitable nor unprofitable, the decision to implement it takes an investor.

Profitability index:

PI =

Rule: If the PI - project effective

If PI <- the project is not effective,

If the PI is the decision to accept the project investor.

Discounting is a special technique for measuring the current and future value of one monetary measure used in the economic and financial analysis.

Learning outcomes and assessment criteria

Learning outcomes **After successful completion of this module, the student**:	**Criteria for evaluation** **The learner must**
RS1 To know the content and direction of the investment policy of the company	1.1 Explain the concept of investment and the investment policy of the company 1.2 To analyze the efficiency of the enterprise investment structure 1.3Umet an estimate for installation of automation

RS2 To know factors affecting the efficiency of investments, sources of financing	2 .1 Explain the positive and negative impact of factors and their contents 2 .2 To know the content of the state in the field of investment policy 2 .3 To know the legislative framework governing the investment activities of enterprises
RS3 is able to perform a feasibility study of projects of automation of technological processes	3 .1 To know content technique feasibility study projects 3 .2 To know and be able to calculate basic indicators methodology 3 .3 To be able to evaluate the effectiveness of projects 3 .4 To be able to apply the method of discounting

PM.11 “Processes and systems modeling “

Aims and objectives

The purpose of this module is to provide training of students in the field of construction and use of a control system model and its elements on the stage of its development and operation.

Introducing module

This module will give students an understanding of modern methods of control systems modelling as a universal tool for all stages of analysis and synthesis of linear control systems with feedback, including the simulation of manufacturing processes as a control object. It provides an understanding of parametric synthesis of automatic control systems. The aims are the selection of the control device structures from a set of known industrial controls and determine its settings.

An integral part of the control system is the control object that is subject to the formalization of the synthesis and analysis of the system.

The module examines the analytical, experimental and combined methods of mathematical description of the object of regulation, which is part of the mathematical description of control systems.

The module examines the systems that are described by linear differential equations with constant parameters; these equations can be solved by using the Laplace transform. Such systems can be characterized by a transfer function and flow characteristics of all of the dependencies between the input and output system.

The module is suitable to students engaged in the process of developing practical circuits control of process parameters. The greatest interest in the field of automation engineering is a closed control loop with negative feedback as most control loops control the lower level are built on this principle. Therefore, actual simulation of the control process in the single-loop control system with negative feedback, the simulation of the transient response of the closed system in order to determine the direct regulation of the quality of evaluations, obtaining the transfer functions of control systems in order to study the stability of the system under development. The most obvious method of analyzing the stability of linear time-invariant systems is their modelling. First developed analogue or digital model of the system, and then made the observation at a typical output variable external influences, or simply by setting non-zero initial conditions. In this case the stability or instability of the system becomes apparent. Often, the control system is necessary to modelling to resort to the process of engineering design. If the actual system contains variables or significant nonlinearity, the simulation may be the only means of determining the properties of the system. There are no general methods for the analysis of complex non-linear and / or non-stationary systems do not exist. Therefore, to determine their characteristics are turning to modelling instead of full-scale testing of real systems.

During the study module students will receive practical skills of computer simulation of control systems for the analysis of stability and determination of the direct control of quality assessments. To illustrate the methods of analysis and synthesis systems, a computer simulation method using programmes such as the SIMULINK, which is part of the integrated environment MATLAB, VisSim is the

software to simulate the motion system models, which has a quality assessment tools, stability, synthesis, correction, optimization, linearization, debug objects in the model circuit. Check various calculations, conversions, solutions of differential equations, graphing functions and other operations are also asked to carry out with the help of simulation software, as well as MathCAD is the engineering mathematical software, which allows you to analyze critical engineering calculations, and share them. Students can make to these programmes your data that will facilitate the solution of problems of development of control systems.

To remove the module from the maximum benefit, the student must have some skills of analysis and synthesis of linear systems, which it acquires by studying before this module "calculation of automatic systems."

This module will enable students to understand the importance of the distinction between real physical systems and their mathematical models. And, although you can see this only as a result of practical work, the student has to realize that such a difference does exist.

This module will enable students to apply different methods of modelling with a specific analysis of their capabilities, application limits, advantages and disadvantages.

The module is suitable to students engaged in the design of control systems, and is based on practical skills obtained during the engineering practice.

Learning outcomes

Upon completion of this module, students should:

1. To know the methods for mathematical description of objects of regulation.

2. Understand the nature of the analysis and synthesis of linear control systems with feedback, methods of parametric synthesis upravleniya.3 systems. 3. 3. To know the regulatory process quality and the linear automatic control systems stability assessment methods.

4. To know the computer modelling programme for calculations and studies of processes and systems.

5. Apply practical methods of computer modelling in the development of control systems.

Module content

1. To know the methods for mathematical description of objects of regulation

The concept of object control. The object, its static and dynamic characteristics structure determination. The mathematical apparatus of modelling. Determination of the order of the differential equation that describes the object. Evaluation inputs and disturbances acting on the object, their statistical characteristics, the point of application, the maximum amplitude. The dynamic delay.

Analytical methods for the mathematical description of objects of regulation. The equations describing the physical, chemical and energy processes occurring in the test object. Mass balance equations. Description of the control objects by differential equations in partial derivatives.

Experimental methods for the mathematical description of objects of regulation for conduct a real series of experiments. The concept of the acceleration curve, obtaining control object acceleration curve, determining the dynamic properties of

an object by its acceleration curve. Ormance method, frequency method for determining the dynamic characteristics, the definition of control objects parameters by least squares.

Combined methods for mathematical description of facilities control. Using the analytical structure of the object obtained in the determination of its parameters in the field experiments.

2. Understand the nature of the analysis and synthesis of linear control systems with feedback control systems parametric synthesis techniques

Mathematical description of automatic control systems by differential equations, linearization of the transfer function.

Tasks analysis of control systems, the definition of its characteristics or behaviour in the closed state.

Tasks synthesis of control systems, the task desired characteristics or behaviour of the system, determination of the structure of a closed system to meet the requirements for its quality.

The definition of a closed system, in which the inputs are a function of its output, and vice versa.

The problem of selecting the control device structure of a set of known industrial controls and determine its tuning parameters.

Methods of determining tuning parameters of typical industrial controllers: logarithmic amplitude-frequency characteristics (LACHH), enhanced the amplitude-frequency characteristics (RACHH), methods of approximate calculation.

Experimental methods for setting the standard knobs: CW method and the method of damped oscillations.

3. To know the methods for assessing the quality of regulation and the stability of linear systems of automatic control of the process

Indicators of the quality of the transition process of a closed system of automatic control.

Transients at typical influences on the system: the unit step function, impulse function, the harmonic function. Evaluation of the quality of the automatic control system when subjected to a single exposure step.

The step response of the closed system of automatic control. Direct regulation of quality assessment (control time, overshoot, oscillation frequency, the number of oscillations, the time to reach the first peak, the rise time of the transition process, the damping rate, and others).

Quality assessment of the automatic control system under the effect of the harmonic signal. The frequency response, phase response, amplitude and phase characteristics of logarithmic characteristic. Indirect regulation of quality indicators: index of oscillation, the resonant frequency, bandwidth, stocks in amplitude and phase.

Investigation of the stability of automatic control systems.

4. To know the computer modelling programme for calculations and studies of processes and systems

The system of computer algebra from the class of computer-aided design MathCAD. Assignment interface, visualization of results of mathematical modelling. Use

MathCAD in teaching, computing and engineering calculations.

Application package for solving automation technical computing MATLAB. Sets of specialized mathematical functions for scientific and engineering calculations. MATLAB interface and command language. Automating data loading. The decision of problems of data analysis and machine learning. Development of algorithms.

Graphical environment Simulink modelling simulation. Construction of dynamic system models using block diagrams in the form of directed graphs. Library blocks for the simulation of electric power, mechanical and hydraulic systems. The use of model-based approach in the design of control systems.

VisSim Visual language programming. Appointment VisSim programmes.

The concept of the principles of operation of the programme VisSim. Graphical interface VisSim. Principles of construction of models in VisSim environment. Using graphic VisSim blocks. Principles of control model and obtain simulation results. Modelling of dynamic systems and design in VisSim.

5. Apply practical methods of computer modelling in the development of control systems

Use one of the methods of computer simulation control objects: electrical circuits, mechanical systems in the linear and rotary movement, electromechanical systems, sensors and others.

The use of computer simulation to visualize the transients in control objects when applied to the input of typical impacts.

Using one of the methods of computer simulation of linear control systems.

Using one of the methods of computer modelling to assess the direct indicators of the quality of automatic control of the process.

Use one of the computer simulation methods to assess the stability of the automatic control system.

Learning outcomes and assessment criteria

Learning outcomes **After successful completion of this module, the student**:	**Criteria for evaluation** **The student must :**
RS1 To know the methods for mathematical description of objects of regulation.	1.1 Select modelling techniques controlled systems to solve practical problems. 1.2 To apply the mathematical apparatus of modelling. 1.3 Develop analytical models of controlled systems using differential equations. 1.4 To apply the experimental methods for the mathematical description of objects 1.5 Get curve acceleration control of the object and its approximate differential equation of the required order.

RS2 understand the essence of the analysis and synthesis of linear control systems with feedback control systems parametric synthesis techniques.	2.1 Explain the nature and objectives of the analysis and synthesis of control systems. 2 .2 To be able to develop a mathematical description of automatic control systems using differential equations and transfer functions 2 .3 Simulate automatic control system using standard industrial controllers P, I, PI, PID. 2 .4 Apply analytical and experimental methods of calculating settings of typical controllers P, I, PI, PID.
RS3 To know the methods for assessing the quality of the regulatory process and the stability of linear automatic control systems.	3 .1 Explain the nature of the transition process of the automatic control system with feedback and methods for its preparation for the determination of the direct regulation of the quality of evaluations. 3 .2 Evaluate the quality of regulation by transient response of automatic control system with feedback. 3 .3 Getting amplitude-frequencies, phase-frequency, amplitude-phase and logarithmic characteristic of the automatic control system. 3 .4 investigate the stability of the system.
RS4 To know computer simulation programme for calculations and studies of processes and systems.	4 .1 Explain computer modelling of processes and systems. 4 .2 Choosing the computer simulation programme for the solution of practical problems in the development of automatic control systems. 4 .3 possesses the skills to use computer programmes for modelling processes and systems.

RS5 apply in practice methods of computer modelling in the development of control systems.	5 .1 use computing in the calculation of mathematical models and evaluation of simulation results. 5 .2 Compile closed block structures of automatic control systems of computer modelling programmes. 5.3 Visualize transients in the control objects and control systems by computer simulation. 5 .4 investigate quality control model of a closed system. 5 .5 To investigate the stability of closed-loop control system model. 5 .6 Identify ways to improve the quality of regulation and the stability of the automatic control system model.

7. Academic (study) plan

Of technical and vocational, post-secondary education

7.1 Academic (study) plan

Speciality: 1302000 -Automation and Control (Automation & Control of Technological Process in Metallurgy and Energy)
Qualifications: Instrumentations and automatic equipment mechanic
Electrician
Junior Engineer Process Automation

form of education: full-time
On qualification:
Instrumentations and automatic equipment mechanic (2 years and 10 months)
Middle level specialist «Electrician» (3 years and 10 months)
«Junior Engineer Process Automation» *continue training for* + 10 months
On the basis of basic secondary education
the total duration of training for all skill levels- 4 years and 10 months

Index	Name of modules practices	Form of control			The amount of teaching time (hours / credits)				Distribution by semesters
		Exam	Credit	ESProject / work	Total	From them			
						Theoretical lessons	Laboratorial and practical, practical training	Training inproduction and professional practice	
1	2	3	4	5	6	7	8	9	10
OOM.00	**Secondary modules**	+	+		**1448**				
OGM.00	**Humanities e modules**	+	+		**380**				**1-7**
BGM.00	**Basic general professional modules**				**767**				**3,4**

BGM.01	Selection and usage of electrical engineering materials, tools and equipment	+			306	148	92	66	3.4
BGM.02	Perusal and development of typical schemes of automation		+		246	138	72	36	3,4
BGM.03	Occupational health and safety compliance		+		170	90	8	72	3,4
BGM 04	Economic basis of entrepreneurial business		+		45	35	10		4
PM.00	**Professional modules**				**2662**				4-9
	Qualifications " Instrumentations and automatic equipment mechanic*»*								
PM.01	Mounting of the control measuring tools	+			348	164	76	108	4,5
PM.02	Exploitation and technical maintenance		+		220	86	36	98	4,5,6
PM.03	Repair works of control measuring tools		+		174	40	36	98	4,5,6
	Qualifications «Electrician»								
PM.04	Design of control and automation systems	+		+	508	292	108	108	5,6,7
PM.05	Checking-out of control and automation systems		+	+	326	156	24	146	6,7
PM.06	Computation of automated systems		+		200	110	40	50	6,7
PM.07	Planning and work organization, assessment of the results	+		+	150	50	20	80	7,9
	Qualifications " Junior Engineer Process Automation *«*								

PM.08	Design of microprocessor systems of automated control		+		236	80	48	108	9
PM.09	Programming of microprocessor instruments of APCS (Automatic process control system)	+			198	90	48	60	9
PM.10	Calculation of economic efficiency of automation project implementation		+		116	50	30	36	9
PM.11	Processes and systems modeling	+			186	90	48	48	9
MddO.00	**Modules defined education organization** **				**671**				3-9
Mml PP 00	**Module manufacturing -learning and professional practice**				**828**				8,9,10
UP 04	Undergraduate practice		+		216				8
DW	Diploma work				216				8
EP 05	Engineeringe practice		+		216				9
EP	Engineering design				180				10
IC	**Intermediate certification**				**288**				
FC 00	**Final certification**				**56**				
FC 01	The final certification in education-al institutions				132				
FC 02 (Aotolptq)	Assessment of the level of profes-sional training and qualification				24				6,8
	Total for compulsory education				**7200**				
C	**Consultations**				Not more than 100 hours on the account. year				
O	**Optional classes**				Not more than 4 hours per week				
	Total hours of study time				**8100**				

Additional notice:

1) * for practical training are: practical (laboratory) works, course papers (projects), examinations and other

2) The development of working curricula and programs of the organization of technical and vocational education can:

- to change up to 30% of training time is spent on the development of training material for cycles and up to 30% in each discipline (module) and up to 50 % of the inservice training and professional practice, with preservation of the total number of hours of compulsory training.
- to select different teaching technologies, forms, methods of organization and control of educational process;
- in accordance with the needs of employers change the content of the curriculum up to 30% in Humanities and socio-economic modules and up to 50% professional modules, industrial training and professional practice. To enter additional module in the professional modules at the request of employers, preserving the total number of hours/credits for compulsory training
- choose the form, procedure and frequency for the ongoing monitoring of learner progress and intermediate certification of students;

3) The Distribution of courses may vary depending on the technology of training, specialty, regional characteristics, and others.

7.2 Academic (study) plan

Speciality: 1302000 -Automation and Control (Automation & Control of Technological Process in Metallurgy and Energy)
Qualifications: Instrumentations and automatic equipment mechanic
Electrician
Junior Engineer Process Automation

form of education: full-time
On qualification:
Instrumentations and automatic equipment mechanic (2 years and 10 months)
Middle level specialist «Electrician» (3 years and 10 months)
«Junior Engineer Process Automation» *continue training for* + 10 months
On the basis of general secondary education
the total duration of training for all skill levels- 4 years and 10 months

Index	Name of modules practices	Form of control			The amount of teaching time (hours / credits)				Distributionby semesters
						From them			
		Exam	Credit	ESPproject / work	Total	Theoretical lessons	Laboratories, work shops	Training in production and profes-sional prac-tice	
1	2	3	4	5	6	7	8	9	10
OGM.00	**Humanities module**	+	+		**460**				**3-6**
BGM.00	**Basic general professional modules**				**767**				**3-6**
BGM.01	Selection and usage of electrical engineering materials, tools and equipment	+			306	148	92	66	3,4

BGM.02	Perusal and development of typical schemes of automation		+		246	138	72	36	3,4
BGM.03	Occupational health and safety compliance		+		170	90	8	72	3,4
BGM.04	Economic basis of entrepreneurial business		+		45	35	10		4
PM.00	**Professional modules**				**2662**				4-9
	Qualifications " Instrumentations and automatic equipment mechanic *«*								
PM.01	Mounting of the control measuring tools	+		+	348	164	76	108	4,5
PM.02	Exploitation and technical maintenance		+		220	86	36	98	4-6
PM.03	Repair works of control measuring tools		+		174	40	36	98	4-6
	Qualifications «Electrician»								
PM.04	Design of control and automation systems	+		+	508	292	108	108	5-7
PM.05	Checking-out of control and automation systems		+		326	156	24	146	6,7
PM.06	Computation of automated systems		+		140	50	40	50	6,7
PM.07	Planning and work organization, assessment of the results	+		+	150	50	20	80	7,9
	Qualifications " Junior Engineer Process Automation «								
PM.08	Design of microprocessor systems of automated control		+		236	80	48	108	9

PM.09	Programming of microprocessor instruments of APCS (Automatic process control system)	+			198	90	48	60	9
PM.10	Calculation of economic efficiency of automation project implementation		+		116	50	30	36	9
PM.11	Processes and systems modeling	+			186	90	48	48	9
MddO.00	**Modules defined education organization** **				**671**				2-9
Mml PP 00	**Module manufacturing -learning and professional practice**				**828**				8-10
UP 04	Undergraduate practice		+		216				8
DW	Diploma work				216				8
EP 05	Engineeringe practice		+		216				9
EP	Engineering design				180				10
IC	**Intermediate certification**				**216**				
FC 00	**Final certification**				**156**				
FC 01	The final certification in educational institutions				132				
FC 02 (Aotolptq)	Assessment of the level of professional training and qualification				24				6,8
	Total for compulsory Education				**5760**				
C	**Consultations**				Not more than 100 hours on the account. year				
O	**Optional classes**				Not more than 4 hours per week				
	Total hours of study time				**6588**				

Additional notice:

2) * for practical training are: practical (laboratory) works, course papers (projects), examinations and other

2) The development of working curricula and programs of the organization of technical and vocational education can:

- to change up to 30% of training time is spent on the development of training material for cycles and up to 30% in each discipline (module) and up to 50 % of the inservice training and professional practice, with preservation of the total number of hours of compulsory training.
- to select different teaching technologies, forms, methods of organization and control of educational process;
- in accordance with the needs of employers change the content of the curriculum up to 30% in Humanities and socio-economic modules and up to 50% professional modules, industrial training and professional practice. To enter additional module in the professional modules at the request of employers, preserving the total number of hours/credits for compulsory training
- choose the form, procedure and frequency for the ongoing monitoring of learner progress and intermediate certification of students;

2) The Distribution of courses may vary depending on the technology of training, specialty, regional characteristics, and others.

8. Explanatory Memorandum to the plan of educational process

The curriculum reveals the structural content of the training, the amount of teaching time per module, the sequence of study modules.

The curriculum and training plan consists of various modules. The term "module" explains the model of "learning areas" that are taught in a combination of theoretical and practical units. Thus, each module focuses on the development and the development of competencies, which are provided in preparation for a degree.

The training plan for the specialty "Automation and Control" is divided into several courses of study cycles:

• General education modules

• humanities modules (example: Professional Kazakh (Russian) language, paperwork in state language, professional foreign language, physical education)

• Basic general professional modules contain hours of theoretical classes, laboratory works and job training

• Professional modules also contain hours of theoretical classes, laboratory works and job training •modules defined education institution **(for** example: the basics of hydraulics, pneumatics and heat engineering, energy bases; ferrous metallurgy furnace, flexible automated control systems, etc.)

• Job training and professional practice include externship qualification "Electrician", diploma and engineering design

• Intermediate certification

• Final certification

• Consulting

• Extracurricular Activities - recommended to the study of the cycle of social orientation courses.

Developed curriculum provides distribution hours modules, forms of control and certifications based on the skill level of students.

Developed curriculum recommends a combination of industrial training with professional modules, i.e. job training is distributed to professional modules.

The amount of teaching time may vary based on the employer's requirements.

The organization of vocational training and professional practice includes the following items:

- Training and production work to instil skills (job training in Laboratories and workshops);

- Training and production work on the development of skills (job training in teaching Laboratories and workshops, professional practice and training in the workplace);

- Professional Practice (technological, undergraduate).

The duration of each type of practice is determined in accordance with the skill of the profile.

Job training is conducted in educational workshops under the supervision of qualified and experienced instructors. Students must master a certain number of related works on the definition of the qualification stage in the period of practice.

Professional practice is carried out in the relevant organizations, the workplace and aims at consolidating the knowledge gained during the training, skills and

professional competences. For the qualification of "technician equipment" this practice is recommended in the second semester of the third year of study, preferably in places where conditions are identified and approvals to operate. Recommended presence of a responsible "experienced personnel" for observation and coaching students in accordance with the curriculum. Details of the organization of professional practice may be part of the contract between the company, the school and the student. Recruiting Companies set their own requirements for the reception specialists on professional practice, taking into account the overall average of the ball in the core disciplines.

Criteria for passing to a higher level are the successful passing of the certification (interim and final).

The interim certification is carried out at the end of the school year. The number of intermediate examinations depends on the skill level.

Recommended interim certification divided into two parts. The first part reflects the content of the relevant year of training modules. Another part reflects the problems and tasks associated with the appropriate level of training (level 3, 4 or 5).

Related content is determined by the content of the intermediate exam modules that are studied by students in this school year. In addition, objectives and tasks shall be defined in such a way as to reflect the appropriate level of training (level 3, 4 or 5).

As a result of interim certification for a modular curriculum and passing the qualification exam for working professions which includes professional readiness level assessment and award students are assigned to the achieved vocational qualification level (category, class, category).

Final certification of students of technical and vocational education institutions includes:

- Assessment of students in educational institutions;
- Assessment of the level of professional training and qualification (for the set and advanced training levels).

Final certification of students in educational institutions is carried out to determine the level of development of educational programmes on the basis of studying the full course of study.

Possible forms of Final certification in educational institutions on the basis of completion of training educational programmes: exams on general subjects (modules) and professional modules or performance and protection of the degree project, or the performance and protection of the thesis with one of the special subjects passing an examination of Final certification (modules).

Assessment of the level of professional training (hereinafter - OUPPK) and qualification "technician equipment", "Electromechanics" specialty consists of two phases:

1) A theoretical test on disciplines (modules), defining training;

2) Implementation of practical tasks by skill level.

The amount of training time to carry out the Final certification is determined by no more than 2 weeks. Of these, the organization and conduct of OUPPK is given at least 12 hours per group (depending on the specifics of the specialty and the organization of educational process may vary upwards).

Consultation and extracurricular activities aimed at ensuring the individual abilities of students and requests.

Extracurricular activities are provided for the entire period of study of the rate of not more than 4 hours a week and are not required to study students.

Consultations are provided in the amount of up to 100 hours per academic year depending on the specialty and training period for a study group.

The amount of time and form of consultation (group, individual, written, etc.) are determined by educational organizations in the preparation of the working curriculum.

The form of completion of education qualification "Electrician" is the performance and protection of the degree project.

The form of the completion of the qualifying education "Junior Engineer" is the performance and protection of the engineering project.

9. A list of recommended equipment

Number	Name	Technical specification	Purpose equipment	The module (s) in which the equipment is used	Note
1	Standard Set of Training Equipment «Electrical materials» poster option, the computer version of ETM-SC	Set mini-module. A set of conductors on «electrical conductivity». Hall Sensor. A device for measuring the insulation resistance. Frame 2 × 4. Laboratory table with a two-compartment. Set of connecting conductors. Guidelines, Technical Specifications, Software USB-oscilloscope	List of laboratory work and experiments: Conductors and semiconductors The study of the temperature dependence of the conductors resistance The study of the temperature dependence of the resistance of semiconductors (the definition of activation energy) Determination of the resistivity of the conductor Contact phenomena in conductors and thermoelectric power (specific thermo power) Photoconductivity The contact phenomena in semiconductors and the barrier photoelectric effect (CVC photodiode, photocurrent,photovoltage) dielectrics Measurement of the dielectric constant of solid dielectrics Measurement of the dielectric loss of solid dielectrics Measuring the dependence of the dielectric constant and dielectric loss of temperature Measurement of the dielectric constant and dielectric loss of active dielectrics. The study of direct and inverse piezoelectric effect (the charge is in direct piezoelectric, piezoelectric modulus, the resonance frequency of the piezoelectric) Electrical breakdown in dielectrics (calculation of electric strength of air) Magnetic materials Removing the primary magnetization curve of a ferromagnet The study of ferromagnetic properties with the help of the hysteresis loop (residual induction, coercive force, specific losses) Determination of the Curie point (the magnetic moment of the atom) The study of magnetic materials (coercive force, specific magnetic energy)	BGM 01, PM 01 PM 02 PM 03	

2	A typical set of training equipment «Theoretical Foundations of Electrical Engineering», the performance of a desktop manual, SOC-HP	Specifications: Power supply voltage 220 V Supply voltage frequency 50 Hz Power consumption, not more than 200 VA Dimensions mm 1260h610h300 Weight not more than 50 kg	Composition: 1. Modules: Power; three-phase power source; resistors; reactive elements; nonlinear elements; chains with distributed parameters; function generator; power meter and phase; measuring (2 pcs); multimeters;physical fundamentals of electrical engineering. 2. The set of modules for the study of the static plane-parallel fields. 3. Frame. 4. Set the connection wires and cables. 5. Technical description of the laboratory stand. 6. Methodical instructions to laboratory work.	BGM01, PM 02 PM 03 PM 05	
3	Standard Set of Training Equipment «Fundamentals of Electronics», monoblock execution manual, OE-MRI	Stand Composition: Modules: Power module and USB oscilloscope Function generator magnetic materials Soft magnetic materials. Temperature coefficient of resistance / capacitance meter RLC Multimeters The barrier effect. photoconductivity Forward and reverse piezoelectric effect.Patchbay Dimensions 900 x 600 x 1404 mm	Monoblock, comprising: a power source; function generator with digital display frequency; a pulse generator (100, 200, 1600 Hz);Analogue and digital measuring instruments; display and control elements; IFSB; Diodes (rectifier, LED, diode Schottky, Zener breakdown diode and Electrical bridge); thyristors (thyristor, triac, GTO-thyristor); transistors (bipolar, field and photon-coupled transistor); operational amplifier; logic elements; trigger; 4-bit counter. 2. The power cord. 3. Set of connecting cables. 4. Technical description of the laboratory stand. 5. Guidelines for the conduct of laboratory work.	BGM01, BGM 03 PM 02 PM 03 PM 05	

4	The laboratory module «Smart Relay ZEN», ZEN-LM	Specifications: Voltage 220V Power Supply voltage frequency 50 Hz Power consumption, no more than 50 VA List of laboratory work: 1. Study of the smart relay OMRON ZEN-10C1DR-D: - The study of the technical characteristics and principles of the relay programming ; - Development and creation of automated process control software via a touch panel of the relay. - 8 different technological objects presented in the form of mimic diagrams: 1) control of heaters furnace; 2) control of induction motor; 3) control of a garland; 4) control line pumping drainage water; 5) traffic; 6) pulse count; 7) running fire; 8) Preparation of a mixture. Dimensions 250 x225x120 mm. Weight not more than 4 kg	C remains: 1. Module installed Smart RelayZEN. 2. Set mimics automation objects. 3. AC power cord. 4. Set the connection wires. 5. The software (CD-ROM). 6. Technical description of the laboratory stand. 7. Guidelines for laboratory work	BGM01, BGM 03 PM 02 PM 03 PM 05	
5	The laboratory module «sensor technology information,» DTI-LM	Specifications: Power supply voltage 220 V Supply voltage frequency 50 Hz Power consumption, no more than 50 VA Dimensions 250 x225h260 mm Weight not more than 4 kg List of laboratory work: The study of information technology sensors: - specifications; - Principles of operation of the sensors; - The performance of the capacitive and inductive sensors in a «road» mode; - The performance of the capacitive and inductive sensors in the «end-face» mode; - Static characteristic of inductive displacement transducers; - The performance of the optical sensor; - The performance of the ultrasonic limit switch; - Performance magnet-sensitive sensors based on Hall sensors and reed switches in a «road» mode; - Performance magnet-sensitive sensors based on Hall sensors and reed switches in the «end-face» mode.	Composition: 1. Unit for the study of technological information sensor assembly. 2. Set of non-contact limit switch (3pcs). 3. Inductive displacement transducer. 4. Set targets for laboratory studies on non-contact limit switches. 5. AC power cord. 6. Technical description of the laboratory stand. 7. Guidelines for laboratory work.	BGM 03, PM 01 PM 02 PM 03 PM05	

6	Standard Set of Training Equipment «Basics of Automation», the performance monoblock hand, OA-MP	Specifications: Power supply voltage 220 V Supply voltage frequency 50 Hz Power consumption, not more than 100 VA List of laboratory work: 1. Research bounce. 2. Measures against contact bounce. 3. Study duration of the on / off switch. 4. Formation of the time delays of signals. 5. The Automation Control of relay elements with automation options schemes: automation control reversible asynchronous motor with a step-off resistance in the rotor circuit; Automation DC control reversible electric motor with one stage when turned off resistance in the anchor chain; pump control automation pumping drainage water; turntable automation; Automation crosshead drill table; Machine for rejection of products; code lock. 6. Automate control logic elements: Synthesis scheme of counting the number of pulses; garland illumination of LEDs 7; automation installation crosshead drill; automation movement of the spindle head of the machine; Automation move the paddle with a pulse sensor; Automation of unsupported stop of elongated metal on the roller conveyor; automation of sheet feeding in the metal at the forge; control of three heating elements furnace resistances. 7. Automation control based on programmable smart relay: automation control heaters furnace; automation of asynchronous motor control; garland control ; automation control line pumping drainage water; traffic light; running fire; automation of compounding. Dimensions mm 500h370h150 Weight, not more than 10 kg	Composition: Bar, including: sources of input discrete signals; Pulse generators 10, 100 and 1000 Hz; 5 of electromechanical relays; logic elements (2 or 4 logical element AND gates 6 3or 4 2I logic element 8 2I gates NOR gates 6 3I-NO); 4 RS- and D-flip-flop;ZEN programmable relay 6 digital inputs (including one analogue input) and 4 digital outputs with the ability to programme typing and viewing on the LCD; three unit delays signals; display unit of 30 LEDs; 2 counters; 2 decoder; 2 seven-segment display; DC motor. Technical description of the laboratory stand. Methodical instructions to laboratory work.	BGM 02, BGM 03, PM 01 PM 02 PM 03 PM 0 4	

7	Standard Set of Training Equipment «Fundamentals of Electronics», monoblock execution manual, OE-MRI	List of laboratory work: Study diodes. A study of the bipolar transistor. Study amplifier stage bipolar transistor. Research and FET transistor amplifier stage. Research photon-coupled transistor. Study thyristors. Research and inverting non-inverting amplifier. Investigation of the active filter and the integrator. Research of comparators. Multivibrator study. The study of logic elements of digital integrated circuits. Research jk-triggerand counter. Study half-wave uncontrolled rectifier. Study half-wave controlled rectifier. Investigation of single-phase electrical bridge rectifier circuit. Investigation of smoothing filters. The study of parametric voltage stabilizer. Dimensions mm 500h400h200 Weight, not more than 10 kg	Composition: 1. Bar, comprising: a power source; function generator with digital display frequency; a pulse generator (100, 200, 1600 Hz);Analogue and digital measuring instruments; display and control elements; IFSB; Diodes (rectifier, LED Schottky diode, Zener breakdown diode, and Electrical bridge); thyristors (thyristor, triac, GTO-thyristor); transistors (bipolar, field and photon-coupled transistor); operational amplifier; logic elements; trigger; 4-bit counter. 2. The power cord. 3. Set the connection wires. 4. Technical description of the laboratory stand. 5. Guidelines for the conduct of laboratory work.	BGM 03, PM 01 PM 02 PM 03 PM 05	

8	Standard Set of Training Equipment «Metrology. Technical measurement « 15 laboratory workMTI-15	Composition: 1.Trammel SHTS- I-150-0,05 2.Micrometer caliperMK25 3.Blade micrometerMR25 4.Lever-type clampCP-25 5.Appliance PB-250 6.Vee block for verification and marking (training) P1-2-2 7.Indicative inside micrometer calliper NO-50 8.Indicative inside micrometer calliper HM-175 9.Set of KMD №2 SW2 10.Set of accessories to CMD PC-2-U 11.Set of wires for measuring thread 12.Versatile stand15ST-M 13.Mount pillar SH- IIN 14.Gear tooth caliper SHZN-18 15.Gear-tooth micrometer BV-5045 16.Sine bar100 mm (training) 17.Pattern collection of tooth (lathe work) 18.Plain gauge-mandrel 19.Taper plug gage 20.Plain gauge clamp 21.Adjustable gage clamp 22.Thread plug gauge 23. Shaft part (2 pcs) 24. Annular collar (2 pcs) 25.Annular collar (ring) 26.Gear member 27.Set of posters (15 pcs) 28. the CD with the methodological guidelines	To train students how to work with the traditional means of measuring linear and details angular parameters.	BGM02, BGM 03, PM 01 PM 02 PM 03 PM 05	

9	Laboratory stand «Methods of measurement of temperature and humidity» MITiV-02	Composition: 1. Temperature calibrator with the operating temperature of 50 to 250 ° C (mini-oven) with microprocessor meter / controller. 2. Temperature calibrator with the working temperature from -5 to 10 ° C (mini fridge on the Peltier elements) microprocessor meter / regulator. 3. Surface temperature calibrator with an operating temperature of 50 to 150 ° C, with microprocessor meter / regulator for non-contact temperature measurements. 4. Set of temperature sensors: thermocouple Chromel-Kopel TCA, thermocouple Chromel-alumel TCA, TSM copper RTD, RTD platinum resistance thermometer - 2 pieces. 5. Precise dual channel temperature meter, resistance, voltage. 6. Infrared pyrometer. 7. Glass thermometer (range 1 ° C). 8. All-purpose meter thermocouple. 9. Humidity calibrators (75% and 33%). 10. Box with variable humidity. 11. Psychrometric hygrometer. 12.Capacity sensor for measuring humidity 13.PC (PERSONAL COMPUTER)preloaded with the operating system, and specialized software 14. Operating Instructions for stand. 15. Recommendations for laboratory work.	1. Study of thermoelectric effects: Seebeck (thermoelectric power), Peltier, and Thomson. The dependence of the amount of heat from the Peltier power and direction of the supplied current, the Peltier coefficient calculation from the experimental data. 2. Learning methods (contact and contactless) measuring the temperature. 3. Investigation of the characteristics of a thermoelectric converter: • Removal of the nominal static characteristic of the thermoelectric converter. • Determination of the thermal inertia of the thermoelectric converter. • Defining reference junction temperature on the static characteristic of the thermoelectric converter. • Study of automatic compensation of the cold junction temperature. 4. Investigation of the characteristics of RTDs: • Removal of the static characteristic resistance thermometer. • Determining the thermal inertia of the resistance thermometer. • Removal of the calibration characteristics of the resistance thermometer. • Determining the impact of a two-wire resistance line. 5. Methods of humidity measurement: • measurement of relative humidity by using psychometric effects; • Measurement of relative humidity by using a capacitive sensor due to changes in the dielectric constant of the medium with humidity changes.	BGM02, PM 03, PM 01 PM 02 PM 03 PM 05	

10	Standard Set of Training Equipment «Measurement and Automation», the performance test bed computer, instrumentation, SC	Specifications: Power supply 220 V Supply voltage frequency 50 Hz Power consumption, not more than 250 VA Dimensions 1400h1350h750 Weight 50 kg List of laboratory work 1. Study of PLC: - Configuring and setting the PLC and I / O channels - Addressing the cycle of automation tasks - Basics of analogue signals 2. Investigation of sensors: The study of current and voltage sensors (measuring shunt, current transformer, the integrated current sensor based on the Hall effect, a voltage divider, the voltage transformer, the integrated voltage sensor based on Hall effect): - The study of the static characteristics of the test sensor; - The study of the frequency characteristics of the test sensors. Study of temperature sensors (thermostat, thermocouple, thermistor silicon, platinum thermistor, an integrated temperature sensor, noncontact thermometer); - The study of the static characteristics of the test sensors. The study of magnetic field sensors (reed switch, a Hall sensor with a digital output, analogue Hall sensor,magnetoresistor discrete output magneto resistor with analogue output); - The performance of the reed switch, the magneto resistor with digital output and a Hall sensor with a digital output; - The study of the static characteristics of the analogue Hall sensor and the magneto resistor with analogue output. 3. The study of signal normalization devices: - Study of Signal Conditioning Module temperature sensors - Study versatile normalizer signals 4. Automated experiments study the characteristics of the sensor	Composition: 1. Modules: Power; technological information sensors; normalizing signal converters; function generator; programmable logic controller. 2. Set mini-module. 3. Personal computer. 4. Laboratory table. 5. Set of the power cables and connecting wires. 6. Technical description of the laboratory stand. 7. Guidelines for laboratory work. 8. The CD disk with the software and the technical documentation on the studied equipment	BGM02, BGM 03, PM 01 PM 02 PM 03 PM 04 PM 05	

11	A typical set of training equipment «Measuring instruments of pressure, flow, temperature» IPDRT	Specifications: 1.1.Pressure in a pneumatic system, MPa 1.2. Rated 0.5 1.3. Maximum 0.6 1.4. Minimum 0.25 1.5. Flow air intake, l / min 0-50 1.6. Power supply AC: 1.7. Voltage, V 220 ± 22 1.8. Frequency Hz 50 1.9. Power consumption (with the compressor and the heating element), kW 2 1.10. The capacity of the storage water tank, l 40 1.11. Feed water pump, l / min 0-35 1.12. The capacity of the air tank, l 10 1.13. Compressor supply, l / min 0-36 1.14. Dimensions (width x depth x height), mm, not more than 1010 x 640 x 2100	Composition: 1.Watertankmounted under the table top; 2.Appliance panel; 3.Receiver compressed air disposed behind the instrument panel; 4.Pressure sensors; 5.Temperature sensors; 6.Rotametr; 7.Water counter; 8.Gas counter; 9.Measuring orifice; 10.Manometers; 11.Pump for supplying water with the expenditure measuring devices, pressure and temperature; 12.Compressor for compressed air supply in the receiver; 13.Block control; 14.Block of matching computer inputs and signals from the sensors; 15.Laptop; 16.Programme software; Educational and methodological support to the description of laboratory work.	BGM 03, PM 01 PM 02 PM 03 PM 04 PM 05	
12	A typical set of training equipment «Industrial Sensors», the performance of bench manual, PD-MAX Wed.	Composition: 1. Bar «Sensors of mechanical values», which comprises: a power supply; an AC voltage generator; block speed sensors; block the angular position sensor; numeric indicators. 2. Monobloc «Sensors technological information», which includes: power supply; generator of DC and AC voltage; current regulator; field voltage and current sensors; field of temperature sensors; field of the magnetic field sensors; field integrated light sensor, numeric indicators; digital multimeter. Dimensions mm 1100h1400h650 Mass, not more than 100 kg.	1. Mini-module package (16 pcs). 2. Set of non-contact limit switches. 3. Inductance displacement transducer. 4. Micrometer stand. 5. Set of targets. 6. Constant magnet (2 pcs). 7.Laboratory table 8.Set of cables and connecting wires 9.Case for mini-module storage 10.Technical description 11. Methodical instructions for laboratory work.	BGM 03, PM 01 PM 02 PM 03 PM 04 PM 05	

13	Standard Set of Training Equipment « Pneumatic and electro pneumatic equipment» SPU-UN-08-14LR-EP	Composition: set of tees (8 pcs); Set of pneumatic tubes - high pressure hoses for assembly of circuits; wire set (24 pieces); air shutoff valve - 1 pc. (Integrated in the unit with filter regulator); Filter pressure regulator with manometer - 1 pc; collector with a lockable quick couplings - 1 item; pneumatic cylinder single acting with spring return 25 mm and stroke of 50 mm - 1 pc .; Pneumatic cylinder double acting: a diameter of 25 mm and a stroke of 100 mm - 1 pc; Pneumatic cylinder double acting: diameter 25 mm, stroke 250 mm - 1 pc; Flow control valve - 2 pcs. Element «And» - 2 pcs; Element «OR» - 2 pcs; 3/2 way valve with roller plunger normally closed type (for use as limit switches) - 2 pcs; Pneumatic button 3/2 normally closed to manually turn on without fixing - 2 pcs; Valve pneumatically operated 3/2 with spring return to the starting position - 1 pc; Valve, pneumatically operated with spring return 5/2 - 1 pc; 5/2 way valve with double air pilot (bistable) - 2 pcs; Electric control valve with spring return 5/2 - 1 pc; distributor 5/2 with two-sided electric control (bistable) - 2 pcs; gauge - 3 pcs; Electromechanical position sensor rod pneumatic cylinder - 1 pc; inductive position sensor rod pneumatic cylinder - 2 pcs; Reed position sensor rod pneumatic cylinder - 1 pc; Description of laboratory work; manual; Compressor. Overall dimensions, not more than, mm: length - 950; depth - 750; height - 400;	The stand is designed for 14 laboratory work on the courses studying pneumatic and electro pneumatic with teaching materials. At the same time work is carried out with a group of 2 ... 3 trained persons.	BGM 03, PM 01 PM 02 PM 03 PM 04 PM 05	

14	Standard Set of Training Equipment «Automated measuring system» AIS	The composition of the basic configuration of the complex: 1.Trammel digital 2.Most calliper to measure the depth 3.Cable callipers communication with a PC 4.Indikatornaya digital head 5.Cable communication with PC display head 6.Vee block verification and marking (training) P1-2-2 7.Mount pillar W-II N 8.Sistemny unit + Monitor 9.Shaft part(2 pcs) 10.Detal type «housing» 11.Detal such as «cover» 12.Detal type «roller» (50 pcs)	It allows you to acquire the skills of effective use of hand-held measuring devices with digital electronic modules either in standalone mode or as part of complex data-measuring systems with computer control.	BGM 01, BGM 03, PM 01 PM 02 PM 03 PM 04 PM 05	
15	Standard Set of Training Equipment «Automation of Heat and ventilation» ATGSV-09-11LR-01	Main specifications: current - single phase; Frequency, Hz - 50; voltage, V - 220; The air pressure at the fan outlet, however, Pa - 300 The highest air flow generated by the fan, in the absence of counter-pressure, m3 / h, not less than - 600 Power consumption, no more kW - 2.0 Overall dimensions, not more than, mm: length - 1500; depth - 620; height - 1800; Weight, not more than, kg - 60.	Composition: - training stand ASTGSV-09-11LR-01 «Automation of Heat and ventilation systems»; -controlling stand for PC (laptop); -manual; - Passport; - Description of the laboratory work.	BGM 03, PM 01 PM 02 PM 03 PM 04 PM 06	
16	Laboratory installation «Automated boiler on liquid and gaseous fuels» AK-01	Composition: Laboratory installation in outdoor performance in the collection, including - physical model of the boiler on the basis of instantaneous electric water heater, with a current capacity equal to the current capacity of the computer model, the circulation of the boiler pumps and the heating system, temperature controller on the boiler outlet coolant flow meters in the boiler circuit and thermal load with electronic count, differential pressure controller in the heating system, the heat load module with adjustable power, coolant temperature gauges at the input and output load, coolant leakage module of the system, equipment for filling and top-up the coolant system, automatic boiler control unit. PC running WIN, specialized software. Cables to connect the PC. Manual Guidelines for laboratory work.	Technical capabilities: the installation includes all of the major units of modern boiler-house; computer model, comprising a modulating burner for liquid or gaseous fuel sensor fuel line pressure, tightness control equipment, a fan, air pressure sensor for the fans, exhaust fans, vacuum sensor in the boiler furnace, the flame sensor; synchronized in time with the power and physical model made on the basis of an electric water heater; manual and automatic generation of various process deviations; input fault in the boiler room equipment; study of the work of regulators using different control laws; automatic control system also has a manual mode; the ability to connect to the boiler variable heat loads; remote monitoring and control of the boiler on the MODBUS RTU protocol.	BGM 03, PM 01 PM 02 PM 03 PM 04 PM 06 PM 08	

17	Standard Set of Training Equipment «Automation and Control», the performance of a desktop computer, ACS-MAX	Specifications: Power supply voltage 220 V Supply voltage frequency 50 Hz Power consumption, not more than 200 VA Dimensions (without a computer) 805h545h310 mm Weight not more than 45 kg List of laboratory work: 1. Study of PLC OMRON CP1L: - Technical specifications, system commands and programming framework; - Variants of tasks for students: resistance furnace; arm (the arm with a gripper) for feeding blanks from the drive in the press; process unsupported stop elongated metal on the roller conveyor; pusher with a crank mechanism with a non-reversible electric motor; truck; product sorting line; switch to move the sheets from the table on the roller conveyor; a pulse generator; automated movement of the punch press is extruded; pusher with a crank mechanism with a reversible electric motor; Control boiler cover; - Development of control programmes issued instructions; - The controller programming and validation of the programme. 2. Learning touch monitor OMRON NT-21: - Technical specifications and programming framework; - Development of control programmes for the controller and touch screen monitor on the tasks assigned; - The controller programming and touch monitor and verify the correctness of the programme; 3. Automation of technological objects: - Up to 12 versions of virtual technological control objects	Composition: 1. Modules: PLC; touch screen monitor; temperature controller; smart relay; panel equipment; technological information sensors. 2. Frame. 3. Set of non-contact limit switches. 4. Set of overhead panels. 5. PC. 6. Set of the power cables and connecting wires. 7. Software (CD-ROM). 8. Technical description of the laboratory stand. 9. Guidelines for laboratory work.	BGM 03, PM 04 PM 05 PM 08 PM 09, PM 11	

18	Standard Set of Training Equipment «automation and controls the Siemens», pursuant to the desktop with a laptop, ACS-MAX, the Siemens-HH	Dimensions (without a laptop and engine) 850h600h300 mm Weight, not more than 25 kg List of laboratory work: 1. Study of the technical characteristics and fundamentals of industrial PLC programming : • configure the controller S7-1200 in the TIA Portal environment; • Controller programming S7-1200 language Ladder Diagram (LD); • addressing the cycle of automation tasks; • basics of working with analogue signals. 2. Learning specifications and HMI programming fundamentals: • Configuring the operator panel KR300 among TIA Portal; • Programming KR300 operator panel. 3. Study of the technical characteristics and fundamentals of programming logic module LOGO: • logic module programming ; • addressing the cycle of automation tasks; • basics of working with analogue signals. 4. Study of the technical characteristics and fundamentals of programming of the frequency converter: • Input motor parameters in the memory of the frequency converter; • Start frequency of the induction motor; • Changing the start time and braking; • programming of fixed engine speeds; • change the engine braking mode. 5. The study of contactless proximity sensors: •specifications; • principles of sensors; • the performance of the capacitive and inductive sensors in a «road» mode; • the performance of the capacitive and inductive sensors in the «end-face» mode; • the performance of the optical sensor; • performance magnet-sensitive sensors based on Hall sensors and reed switches in a «road» mode; • performance magnet-sensitive sensors based on Hall sensors and reed switches in the «end-face» mode.	Composition: Modules: Power; PLC S7-1200; KR300 operator panel; programmable device LOGO Siemens; frequency converter SINAMICS; mechanical quantities sensors; «Methodical the stove.» 1. Non-synchronous engine flywheel. 2. Set of auxiliary equipment for laboratory work. 3. Laptop. 4. Bearing support. 5. Set of connecting cables and wires. 6. Programme software (CD-ROM). 7. Technical description of the laboratory stand. 8. Methodical instructions for laboratory work.	BGM 03, PM 04 PM 05 PM 08 PM 09, PM 11	

		6. The study of contactless position sensors: 7. Study of speed sensors: 8. The study of automation of technological processes (4 variants of virtual objects): • Cover control mechanisms soaking pits roughing mill (heating well); • sorting and packaging station suitable and defective sheets of metal (sorting sheets); • transporting portion of large diameter pipes; • Chemical processing line parts (dry line); 9. The study of automation of technological processes (1 variant simulation object): 10. Study of the fieldbus PROFINET 11. A study of industrial networks based on standards RS485			

10. List of recommended literature

Number	Name and number of the edition	Author	Publisher, year and place of publication	The module (s),in which is used
1	Automation of technological processes ISBN 9785769599033	Shishmarev V.Y.	Moscow , «Academy», 2013	BGM 02, PM 02 PM 04 PM 05
2	Fundamentals of automation of technological processes and production ISBN 978-5-7038-4137-2	Edited by Evgenev G.B.	Moscow, Publishing house of the MSTU.Bauman, 2015	BGM 02, PM 02 PM 04 PM 05
3	Theory and technology control systems. Multifunction SCADA of thermal power plants. In 3 Vol. Bk. 1. Challenges and tasks. Bk. 2. Designing. Bk. 3. Modelling.	Under the general editorship of Doctor of Engineering Science,Prof. Tverskoy Y.S.;	FEDERAL STATE EDUCATIONAL INSTITUTION OF HIGHER PROFESSIONAL EDUCATION The “Ivanovo State Power University. Lenin. “ - Ivanovo, 2013	PM 04 PM 06 PM 09
4	UML language. User Manual /: Trans. from English by Slinkin A.A. - 2nd edition.	Grady Booch, James Rumbaugh, and Ivar Jacobson	M .: DMK Press, Peter 2014	PM 08 PM 09
5	Design of microprocessor systems and devices (Tutorial)	Astapov V.N.	International Journal of Experimental Education. - 2015. - № 12-1. - P. 87-89;	PM 08
6	Electric actuators. Principles of planning, application solutions. The ISBN 978-3- 89578-434-7	Weidauer Jens, Messer Richard	Germany, Erlangen 2014	PM 04 PM 05

7	Automation with STEP 7 in LAD and the FBD the SIMATIC the S 7-300 / 400 Programmable Controllers The ISBN : 978-3- 8957 the S -410-1	1. Berger Hans	Germany, Erlangen 2014	PM 08 PM 09
8	LOGO! Practical training of the ISBN : 978-3- 8957 the S -410-1	Stefan Kruse	Germany, Erlangen 2015	PM 04
9	Entertaining electronics and electrical engineering for beginners and not only	Vanyushin M.	Publisher: Science and Technology, 2016	BGM 01 BGM 02 PM 05
10	Power in modern technologies.	Novikov V.A.,, Sawa S.V., Tatarintsev N.I.	Moscow: «The Academy» 2014	PM 04 PM 05
11	Fundamentals of programming microcontrollers.	Vasilev A.S., Lashmanov O.J., Pantyushin A.V.	SPb: ITMO, 2016	PM 09
12	2. Automatic Electric in modern technologies: a textbook UDK621.34-52 C37 (electronic textbook http://www.knigafund.ru/books/187048) the ISBN :978 -5-7782-2400-1	Simakov G.M.	Novosibirsk, Novosibirsk State Technical University, 2014	PM 04 PM 05
13	3. Automatic electric control: a tutorial 4. UDK621.34-52 P164 (electronic textbookhttp://www.knigafund.ru/books/187048) the ISBN : 978 -5-7782-2223-6	Pankratov V.V.	Novosibirsk, Novosibirsk State Technical University, 2013	PM 04 PM 05
14	Automation: A textbook for students of secondary vocational education institutions	Alexander A.	M .: Akademiya, 2013.	PM 02 PM 04 PM 05
15	Modern automation in process control systems: Textbook	Ivshin V. P., Peruhin M.Y.	SIC M .: INFRA-M, 2013	PM 02 PM 04 PM 05
16	Relay protection and automation of electric power systems: A Textbook for students. Media institutions. Prof. education	Kireyeva E.A. Tsyruk S.A.	M .: Academy of IC 2013	PM 02 PM 04

17	Practical Automation: Directory	Kisarimov R.A.	M .: RadioSoft 2013	PM 02 PM 04 PM 05
18	Automation: Tutorial and Workshop for Academic Bachelor	Serebryakov A.S.	Lyubertsy: Yurayt 2016	PM 08 PM 09
19	Fundamentals of Thermal Engineering. Heat control and automation of boilers: the textbook for beginning. Prof. education	Sokolov B.A.	M .: Academy of IC 2013	PM 04
20	Synchronous electrical machines reciprocation: A study guide in the field of «Electromechanics» and «Electric drive and automation»	Hiterer M.J.	«St. Petersburg :. CORONA-print 2013	PM 02
21	Fundamentals of automation of technological processes of gas and water purification: Lectures.	Berdyshev V.F. Shatokhin K.S.	. M .: MISA 2013	PM 02 PM 04
22	Methodological bases automate the design and technological design of flexible multilayer printed circuit boards	Mylov G.V., Taganov A.I.	M .: GLT 2014	PM 01 PM 02
23	Fundamentals of automation of production: Textbook for institutions of primary vocational education	Panteleev V.N., Proshin V.M.	M .: Academy of IC 2013	BGM 01 BGM 02
24	Fundamentals of automation of technological processes: A manual for the ACT.	Shchagin A.V.	Lyubertsy: Yurayt 2016	BGM 01 BGM 02 PM 02
25	Software testing. Implementation, control and automation. Trans.from English by Pavlov M.	Dustin E., D. Raschke, Paul D.	M .: Lori, 2013	PM 09
26	Automate configuration control systems the ISBN 978-5-91872-091-2	Klyuyev A.S., Rotach V.Y., Kuzishchin V.F.	M .: Alliance 2015	PM 09
27	Energy saving and automation of production in the thermal power sector of the city. VFD: Textbook	Krylov, Y.A., Karandayev A.S., Medvedev V.N.	St. Petersburg:. Lan 2013	PM 08

28	Engineering Drawing and automating the drawings: Textbook for applied bachelor	Levitsky V.S.	Lyubertsy: Yurayt 2016	PM 04
29	Automation of Heat and ventilation systems.	Mukhin O.A.	M .: Alliance 2015	PM 02
30	Process Automation	Selevtsov L.I.	Vologda: Infra-Engineering 2014	PM 02 PM 04
31	Automation Product Lifecycle Control : A textbook for students of higher education institutions,	Skvortsov A.V., Skhirtladze A.G., Chmyr D.A.	M .: “Academy” Publishing Centre, 2013	PM 02 PM 07
32	Automation of technological processes: Textbook	Skhirtladze A.G., Bochkarev S.V., Lykov A.N.	Stary Oskol: TNT, 2013	PM 02 PM 04
33	Energy saving and automation of production in the thermal power sector of the city. VFD: Textbook	Yudovich V.I.	St. Petersburg :. Lan 2013	PM 04 PM 05
34	Automatic control systems: theory, application simulation in the MATLAB: Textbook	Agrawal G.P.	St. Petersburg:. Lan 2013	PM 06
35	The theory of automatic control. The main provisions. Calculation examples: Textbook	Vlasov K.P.	Kharkov: Guman. Centre 2013	PM 06
36	Theory of automatic control in the examples and problems with solutions in the MATLAB: Textbook	Haiduk A.R., Belyaev V.E.	St. Petersburg:. Lan, 2016	PM 06
37	Theory of automatic control in the examples and problems with solutions in the MATLAB: Textbook	Gurevich A.P., Kornev V.V., Khromov A.P.	St. Petersburg:. Lan, 2016	PM 06
38	Automatic Control Theory: A Tutorial	Guenther N.M.	St. Petersburg:. Lan, 2016	PM 06
39	The theory of automatic control (using MATLAB -SIMULINK): Textbook	Guenther N.M.	St. Petersburg:. Lan, 2016	PM 06
40	The theory of automatic control. Problems and solutions: Textbook	Dankov V. V., Skripnichenko M.M., Gorbacheva N.N.	St. Petersburg:. Lan, 2016	PM 06

41	Automatic Control Theory: Tutorial and Workshop for Academic Bachelor	Kim D.P.	Lyubertsy: Yurayt 2016	PM 06 PM 08
42	Automatic Control Theory: A Tutorial	Konovalov B.I., Yuri Lebedev	St. Petersburg:. Lan, 2016	PM 06 PM 08
43	The theory of automatic control (using the MATLAB - SIMULINK): Textbook	Kudinov Y.I., Pashchenko F.F.	St. Petersburg:. Lan, 2016	PM 06 PM 08
44	Automatic control systems: theory, application simulation in the MATLAB: Textbook	Oschepkov A.Y.	St. Petersburg:. Lan 2013	PM 08 PM 11
45	Automatic Control Theory	Yurevich E.I.	St. Petersburg:. BHV, 2016	PM 06 PM 08
46	Applied metrology: The quantities and measurements. Tutorial.	Gvozdev V.D.	M .: MIIT, 2015	PM 04
47	Instrumentation and Process Control ISBN 978-1418041717	Terry Bartelt		PM 04
48	Analogue and Digital Control Systems ISBN 978-0130330284	Ramakant Gayakwad, Leonard Sokoloff		PM 04 PM 05
49	Mechatronics: the Control of Electronic Systems' in the Mechanical and Electrical Engineering (6Th Edition is.) ISBN 978-1292076683	W. Bolton		PM 09 PM 11
50	Labour Economics: A Textbook for bachelors	Aliyev I., Gorelov N., Ilyina L.O.	M .: Yurayt 2013	PM 10
51	Psychology and ethics of business communication: the textbook for undergraduate	Borozdina G.V., Kormnova N.A.	M .: Yurayt 2013	PM 07
52	The organization of production at the industrial enterprises: a textbook	Ivanov I.N.	M .: INFRA-M, 2013	PM 07
53	The organization of production at the industrial enterprises: a tutorial	Pereverzev M.P., Logvinov S.S.	M .: INFRA-M, 2013	PM 07
54	Business Communication: a textbook. - 2nd ed. Updated and revised	Konopleva I.A.	M .: INFRA-M, 2013	PM 07

55	Macroeconomics: A Textbook for bachelors	Tarasevich L.S.	M .: Yurayt 2013	PM 10
56	Methods of control decision-making: a text-book for undergraduate	Tebekin A.V.	M .: Yurayt 2013	PM 10
57	Economics and Control in Energy: a text-book for graduate; EMA recommended the Board of Education in Control	Lyubimov N.G., Petrovsky E.S.	M .: Yurayt 2014.	PM 10
5 8	Functional safety.	Smith, D.D., Simpson C.D.	Publishing house «Technologies», M .: 2004	BGM 03
5 9	Classification and fields of application of electrical installations in fire-hazardous areas: A Reference Guide.	Smelkov G.I., Cherkasov V.N., Shestitko E.L.	M .: VNIIPO 2012	BGM 03 PM 04
60	Health and Safety. Occupational Safety and Health: A Textbook for bachelors	Belyakov G.I.	M .: Yurayt 2013.	BOM 03
61	Cross-industry regulations on labour protection (safety) for operation of electrical installations; POT RM-016-2001. RD 153-34.0-03.150-00 ISBN 978-5-370-03206-6		Moscow: Omega-L, 2014	PM 04 PM 08
62	Safety and labour protection in the Republic of Kazakhstan. Collection of normative acts. The rules and requirements. typical instructions		LEM (Lem), 2016	BGM 03
63	First aid in emergency situations	Kurdayev T.F.	«Standard Group Ltd» , 2007	BGM 03
64	Occupational safety when working at height. 2nd ed., Updated and revised	Mikhailov Y.M.	M .: Alfa-Press, 2016	BGM 03

65	Industrial safety and labour protection. Reference manager (specialist) hazardous production facilities	Mikhailov Y.M.	M .: Alfa-Press, 2014	BGM 03
66	Occupational safety in the operation of electrical installations. 2nd ed., Updated and revised	Mikhailov Y.M.	M .: Alfa-Press, 2016	BGM 03
67	Occupational safety and electrical safety. Edition 3.	Sibikin Y.D.	Vologda: Infra-Engineering 2014	BGM 03
68	Occupational Safety and Health. Tutorial.-	Korobko V.I.	M .: UNITY 2013	BGM 03
69	Materials science and technology of materials: Textbook	Adaskin A.M. Zuev V.M.	M .: Forum, SIC INFRA-M, 2013	BGM 01
70	Materials: A Textbook	Bogodukhov S.N.	M .: Engineering, 2015	BGM 01
71	Materials for technical colleges: Tutorial	Vishnevetsky Y.T.	M .: Dashkov & C, 2013	BGM 01