



**Institute of Energy and Mechanical Engineering named after A. Burkitbayev
Department of "Technological machines and equipment"**

EDUCATIONAL PROGRAM

6B07132 «Predictive technologies and machine diagnostics»

Code and classification of the field of education	6B07 «Engineering, manufacturing and civil engineering»
Code and classification of training directions	6B071 «Engineering and engineering trades»
Group of educational programs	B064 «Mechanics and metal working»
Level based on NQF	6
Level based on IQF	6
Study period	4 years
Amount of credits	240

Almaty 2024

Educational program 6B07132 «Predictive technologies and machine diagnostics» was approved at the meeting of K.I. Satbayev KazNRTU Academic Council Minutes # 12 dated «22» April 2024

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Educational program 6B07132 «Predictive technologies and diagnostics of machines» was developed by Academic committee based on direction 6B071 «Engineering and engineering trades»

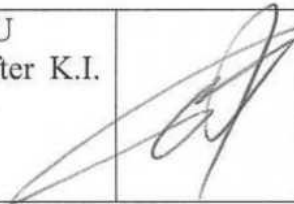




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List of abbreviations and designations

NCJS KazNRTU named after K. I. Satbayev – NCJS «KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I. SATBAYEV»;
SOSE – State obligatory standard of education of the Republic of Kazakhstan;
EP – educational program;
IWS – independent work of a student (student, undergraduate, doctoral student);
IWSST – independent work of a student with a teacher (independent work of a student (undergraduate, doctoral student) with a teacher);
WC – working curriculum;
UC – university component;
CC – component of choice;
NQF – National Qualifications Framework; S
QF – Sectoral Qualifications Framework;
LO – learning outcomes;
KC – key competencies

1. Description of the educational program

The field of professional activity of the bachelor of the educational program «Predictive technologies and machine diagnostics» includes:

- sections of science and technology that contain a set of tools, techniques, methods and methods of human activity aimed at creating competitive mechanical engineering products and based on the use of modern methods and tools for design, calculation, mathematical, physical and computer modeling;
- organization and execution of works on creation, installation, commissioning, maintenance, operation, diagnostics and repair of technological machines and equipment, development of technological processes for the production of parts and assemblies.

The objects of professional activity of the bachelor are:

- technological machines and equipment of various complexes;
- technological equipment and means of mechanization and automation of technological processes;
- production technological processes, their development and development of new technologies;
- installation and repair of technological machines and equipment;
- means of information, metrological, diagnostic and management support of technological systems to achieve the quality of manufactured products;
- means of testing and quality control of technological machines and equipment;
- technological processes of assembling metal structures;
- welding equipment and power supplies, assembly and welding devices;
- normative and technical documentation, systems of standardization and certification, methods and means of testing and quality control of products.

Types of professional activity are:

- experimental and research activities;
- calculation and design and analytical work;
- production and technological infrastructure;
- service and maintenance;
- installation and adjustment;
- organizational and managerial information.

The bachelor's professional activity subjects are:

- technological machines and equipment; power equipment;
- machine drive systems;
- traffic management systems;
- operator's life support systems;
- structural and operational materials;
- equipment for manufacturing, testing and recycling of technological machines;
- equipment for maintenance and repair of technological machines;
- control and measuring devices for the manufacture and operation of machines;
- equipment for automating machine work processes;
- machine design equipment

2. Goals and objectives of the educational program

The purpose of the OP: The purpose of the educational program is to provide comprehensive and high-quality training of competitive, highly qualified specialists who are ready to solve practical and theoretical problems in predictive diagnostics in professional activities in modern conditions based on digital maintenance systems» is to provide comprehensive and high-quality training of competitive, highly qualified specialists who are ready to solve practical and theoretical problems on the reliability of professional activity in modern conditions based on the development of predictive maintenance systems, skills and abilities necessary for a future specialist.

OP tasks:

- studying the cycle of general education disciplines to ensure social and humanitarian education based on the laws of socio-economic development of society, history, modern information technologies, the state language, foreign and Russian languages;

- study of the cycle of basic disciplines that provide knowledge of natural, general technical and economic disciplines as the basis of professional education;

- the cycle of basic disciplines is aimed at studying the main theoretical aspects of the reliability of technological machines, theoretical and practical methods, areas of human activity based on the creation of competitive technological machines and modern digital design methods and tools, predictive maintenance systems, mathematical, physical and computer modeling of technological processes;

- study of disciplines that form the skills of planning and organizing research work, designing reliable technologies and devices;

- familiarization with technologies and equipment of enterprises at different stages of practical training;

- mastering the skills and abilities of laboratory research, technological calculations, selection and design of equipment using modern computer technologies and programs

3. Requirements for evaluating the learning outcomes of an educational program

The scope of the bachelor's degree program is 240 credits, regardless of the form of study, the educational technologies used, the implementation of the bachelor's degree program using a network form, the implementation of the bachelor's degree program according to an individual curriculum, including accelerated learning.

Descriptors of the level and scope of knowledge, skills, and competencies

A – knowledge and understanding:

A1 - Ability to logically represent the acquired knowledge and understanding of systemic relationships within disciplines, as well as interdisciplinary relationships in modern science.

A2-Knowledge of approaches and methods of critical analysis, the ability to use them practically in relation to various forms and processes of production.

A3-perform basic calculations of the main parameters of technological machines, justify their choice depending on the production levels.

B-Applying knowledge and understanding

B1-Independent development and promotion of various options for solving professional problems using theoretical and practical knowledge

B2-put forward hypotheses for acquiring new knowledge necessary for daily professional activities and continuing education

B3 - on the basis of basic knowledge, be able to navigate adequately in various situations

C – forming judgments

C1 - on the basis of knowledge about economic patterns formation of hypotheses, forecasting and planning of economic activity of the enterprise.

C2 - be able to work in a team, correctly defend your point of view, and offer new solutions.

CC3 - skills of daily acquisition of new knowledge necessary for professional activity.

D – personal abilities

D1 - compliance with the standard of business ethics, possession of ethical and moral standards of behavior.

D2-ability to find a compromise, correlate your opinion with the opinion of the team

D3-know social and ethical values based on public opinion, traditions, customs, and social norms and be able to navigate them in their professional activities.

Completion competencies

General Cultural competencies (CA)	
OK 1	Ability to communicate in oral and written forms in the state, Russian and foreign languages to solve problems of interpersonal and intercultural interaction
OK 2	Understanding and practical use of healthy lifestyle standards, including prevention issues, the ability to use physical culture to optimize performance
OK 3	Ability to analyze the main stages and patterns of historical development of society for the formation of civil
OK 4	Ability to use the basics of philosophical knowledge to form a worldview position
OK 5	Ability to critically use the methods of modern science in practical activities
OK 6	Awareness of the need and acquisition of the ability to independently learn and improve their skills throughout their working life
OK 7	Knowledge and understanding of professional ethical standards, proficiency in professional communication techniques
OK 8	Ability to work in a team tolerant perception of social, ethnic, confessional and cultural differences
OK 9	Ability to use the basics of economic knowledge in various fields of activity
General Professional competencies (GIC)	
OPK-1	Ability to acquire new knowledge with a high degree of independence using modern educational and information technologies
OPK-2	Possession of computer skills sufficient for professional activity with basic programming
OPK-3	Knowledge of the main methods, methods and means of obtaining, storing, processing information, the ability to use modern technical means and methods for solving communication problems. information technologies using traditional information carriers, distributed knowledge bases, as well as information in global computer networks

OPK-4	Understanding of the essence and significance of information in the development of modern society, the ability to receive and process information from various sources, the willingness to interpret, structure and formalize information in a form accessible to others
OPK-5	Ability to solve standard problems professional activity based on information and bibliographic culture with the use of information and communication technologies and taking into account the basic requirements of information security
Professional competencies (PC)	
PC 1	Ability to systematically study scientific and technical information, domestic and foreign experience in the relevant training profile
PC 2	Ability to take part in the preparation of scientific reports on the completed task and implement the results of research and development in the field of technological machines and equipment
PC 3	Ability to participate in work on innovative projects using basic research methods
PC 4	Ability to model technical objects and technological processes using standard packages and computer-aided design tools, willingness to conduct experiments using specified methods with processing and analysis
of PC 5 results	Possession of approaches and methods of critical analysis, the ability to use in practice with regard to various forms and processes of technological processes of
SC 6	the Ability to learn a new technique, technological and technical documentation make adjustments with respect to operating conditions
7 PC	the Ability to participate in work on the calculation and design of details and units of technological machines in accordance with the technical tasks and use the standard tools of design automation
PC 8	Ability to conduct patent research to ensure the novelty of the new design solutions and their patentability and the identification of indicators of technical level of engineered products
PC 9	Ability to explore and optimize the modes of operation of technological machines during their operation
PC 10	the Ability to pre-technical-economic justification of design solutions
PC 11	the Ability to design technical equipment jobs with accommodation of technological equipment, the ability to learn the input equipment
PC 12	the Ability to participate in work on fine-tuning and development of technological processes during the preparation of the production of a new product, to check the quality of the installation and commissioning testing and commissioning of new types of products, components and parts manufactured products
PC 13	the Ability to check the technical condition and residual life of process equipment, arrange a routine inspection and maintenance of technological machines and equipment
PC 14	the Ability to carry out activities for the prevention of occupational accidents and occupational diseases, to monitor compliance with environmental safety of the operations
PC 15	the Ability to choose the main and auxiliary materials, methods of implementation of technological processes, to apply advanced methods of operation of technological equipment
PC 16	to Wield the main methods of calculation of parameters of technological equipment, the method of their selection on the directories and catalogs.

4. Passport of the educational program

4.1. General information

№	Field name	Note
1	Code and classification of the field of education	6B07 «Engineering, manufacturing and civil engineering»
2	Code and classification of training directions	6B071 «Engineering and engineering trades»
3	Educational program group	B064 «Mechanics and metal working»
4	Educational program name	“Predictive technologies and machine diagnostics»
5	Short description of educational program	Educational program "Reliability and predictive maintenance of technological machines and equipment" in the following industries: - metallurgical machinery and equipment; - mining machinery and equipment; - machinery and equipment of the oil and gas industry;
6	Purpose of EP	The purpose of the educational program is to provide comprehensive and high-quality training of competitive, highly qualified specialists who are ready to solve practical and theoretical problems in predictive diagnostics in professional activities in modern conditions based on digital maintenance systems.
7	Type of EP	Innovative EP
8	The level based on NQF	6
9	The level based on IQF	6
10	Distinctive features of EP	no
11	List of competencies of educational program	QC 1. Communication QC 2. Basic literacy in the natural sciences QC 3. General engineering competencies QC 4. Professional competencies QC 5. Engineering and computer competencies QC 6. Engineering and working competencies QC 7. Socio-economic competencies QC 8. Special professional competencies
12	Learning outcomes of educational program	LO1: Apply the basic patterns and forms of regulation of social behavior, the rights and freedoms of man and citizen, demonstrating respect for people, tolerance for another culture, readiness to maintain partnerships LO2: Demonstrate knowledge and skills of sections of natural disciplines: higher mathematics, physics and related disciplines and apply them to solve engineering problems in the field of predictive technologies and machine diagnostics LO3: Assign materials and design a technological process and methods for manufacturing basic technological parts, elements and assemblies using advanced methods for obtaining machine parts LO4: Analyze and choose the main methods, methods and means of obtaining, storing, processing special information, know the basics of programming for

		<p>database management, be able to use digital data to solve communication problems for modern technical systems and the use of information technologies for the use of global information networks</p> <p>LO5: Regulate the procedure and procedure for installation and commissioning during testing and operation of the diagnosed equipment. Assess the technical condition and residual life of process equipment, organize routine inspection and maintenance of equipment using diagnostic tools, process the results of system measurements</p> <p>LO6: Apply effective progressive methods to develop low-waste, energy-saving technologies that ensure the safety of people's life and protect them from the possible consequences of accidents, catastrophes and natural disasters, ways of rational use of raw materials, energy and other types of resources</p> <p>LO7: Apply knowledge of economic laws, labor protection and environmental standards, rules of moral development, culture of academic integrity at a professional level</p> <p>LO8: Apply standard calculation methods in the design of parts and assemblies of technological machines and welded structures. Use standard design automation tools in calculations</p> <p>LO9: Possess regulatory, economic and organizational knowledge when conducting business in the conditions of the Kazakh economy. Know professional ethics, ethical codes, generally accepted business rules. Know the concept, content and types of corruption</p> <p>LO10: Demonstrate the knowledge and skills necessary to ensure the reliability of technological machines, advanced technological processes and methods of operation of technological equipment, the quality of products and objects</p> <p>LO11: Demonstrate knowledge and skills in the field of dynamics, reliability and technical diagnostics of technological machines of the main and auxiliary production</p> <p>LO12: Apply knowledge in the field of operation and repair of machinery and equipment for the integrated management and monitoring of industrial production</p> <p>LO13: Formulate system knowledge for independent research in the field of predictive analysis of machinery and equipment. Analyze theoretical and experimental research in order to modernize or create new methods</p> <p>LO14: Possess scientific and practical knowledge in the field of operation to solve current engineering and scientific problems in the field of quality, operational properties and rational use of diagnostic devices</p>
13	Education form	full
14	Period of training	4 years

15	Amount of credits	240
16	Languages of instruction	Kazakh/Russian
17	Academic degree awarded	Bachelor of Engineering and Technology
18	Developer(s) and authors:	Academic Affairs Committee

4.2. Relationship between the achievability of the formed learning outcomes based on educational program and academic disciplines

№	Name of the discipline	Short description of the discipline	Number of credits	Generated learning outcomes (codes)													
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10	LO11	LO12	LO13	LO14
Cycle of general education disciplines Required component																	
1	English language	English is a discipline of the general education cycle. After determining the level (according to the results of diagnostic testing or IELTS results), students are divided into groups and disciplines. The name of the discipline corresponds to the level of English proficiency. During the transition from level to level, the prerequisites and post-prerequisites of the discipline are observed	5	v													
2	Kazakh (Russian) language	The socio-political, socio-cultural spheres of communication and functional styles of the modern Kazakh (Russian) language are considered. The course highlights the specifics of scientific style in order to develop and activate professional and communicative skills and abilities of students, allows students to practically master the basics of scientific style and develops the ability to perform structural and semantic analysis of the text	5	v													
3	Information and communication technologies (in	Required component. The task of studying the discipline is to acquire theoretical knowledge about	5				v										

	English)	information processes, about new information technologies, local and global computer networks, methods of information protection; to acquire skills in using text editors and tabular processors; to create databases and various categories of application programs															
4	History of Kazakhstan	The course studies historical events, phenomena, facts, processes that took place on the territory of Kazakhstan from ancient times to the present day. The sections of the discipline include: the steppe empire of the Turks; early feudal states on the territory of Kazakhstan; Kazakhstan during the Mongol conquest (XIII century), medieval states in the XIV-XV centuries. The epoch of the Kazakh Khanate XV-XVIII centuries. Kazakhstan as part of the Russian Empire, Kazakhstan during the Great Patriotic War, during the formation of independence and at the present stage	5	v													
5	Philosophy	Philosophy forms and develops critical and creative thinking, worldview and culture, provides knowledge about the most general and fundamental problems of existence and gives them a methodology for solving various theoretical and practical issues. Philosophy expands the horizon of vision of the modern world, forms citizenship and patriotism, promotes	5	v													

		self-esteem, awareness of the value of human existence. It teaches you to think and act correctly, develops practical and cognitive skills, helps you to search and find ways and ways of living in harmony with yourself, society, and the world around you															
6	Module of socio-political knowledge (sociology, political science)	The study of the course contributes to the formation of students' theoretical knowledge about society as an integral system, provides the political aspect of training a highly qualified specialist on the basis of modern world and domestic political thought. The discipline is designed to improve the quality of both general humanitarian and professional training of students. Knowledge in the field of sociology and political science is necessary to understand political processes, to form a political culture, to develop a personal position and a clearer understanding of the measure of one's responsibility	3	v													
7	Module of socio-political knowledge (cultural studies, psychology)	The module of socio-political knowledge (cultural studies, psychology) is designed to familiarize students with the cultural achievements of mankind, to understand and assimilate the basic forms and universal patterns of formation and development of culture. During the course of cultural studies, general problems of the theory of	5	v													

		culture, leading cultural concepts, universal patterns and mechanisms of formation and development of culture, the main historical stages of the formation and development of Kazakh culture are considered. The regularities of the emergence, development and functioning of mental processes, states, properties of a person engaged in a particular activity, the regularities of the development and functioning of the psyche as a special form of vital activity are also studied															
Cycle of general education disciplines																	
Component of choice																	
8	Fundamentals of anti-corruption culture and law	Purpose: to increase the public and individual legal awareness and legal culture of students, as well as the formation of a knowledge system and a civic position on combating corruption as an antisocial phenomenon. Contents: Content: improvement of socio-economic relations of the Kazakh society, psychological features of corrupt behavior, formation of an anti-corruption culture, legal responsibility for acts of corruption in various fields.	5							v		v					
9	Fundamentals of economics and entrepreneurship	Purpose: To develop basic knowledge of economic processes and skills in entrepreneurial activities. Content: The course aims to develop skills in analyzing economic concepts such as supply and demand, and market	5							v		v					

		equilibrium. It includes the basics of creating and managing a business, developing business plans, risk assessment, and strategic decision-making.															
10	Fundamentals of scientific research methods	Purpose: to form a systematic understanding of the methodology of scientific cognition among students; to develop scientific thinking skills; to form experience in organizing and conducting scientific research; to develop a competence-based approach to the use of methods and rules for conducting research in the field of mechanical engineering, related processes and their technologies. Contents: stages of scientific research, terms and concepts, methods of conducting an experiment, mathematical methods of processing research results. Concepts of engineering, laboratory and industrial experiment, bench research.	5				v										v
11	Basics of Financial Literacy	Purpose: formation of financial literacy of students on the basis of building a direct link between the acquired knowledge and their practical application. Contents: using in practice all kinds of tools in the field of financial management, saving and increasing savings, competent budget planning, obtaining practical skills in calculating, paying taxes and correctly filling out tax reports, analyzing	5						v		v						

		financial information, orienting in financial products to choose adequate investment strategies.															
12	Ecology and life safety	Purpose: formation of ecological knowledge and consciousness, obtaining theoretical and practical knowledge on modern methods of rational use of natural resources and environmental protection. Contents: the study of the tasks of ecology as a science, the laws of the functioning of natural systems and aspects of environmental safety in working conditions, environmental monitoring and management in the field of its safety, ways to solve environmental problems; life safety in the technosphere, emergencies of a natural and man-made nature.	5						v	v							
Cycle of basic disciplines University component																	
13	Mathematics I	Purpose: to introduce students to the fundamental concepts of linear algebra, analytical geometry and mathematical analysis. To form the ability to solve typical and applied problems of the discipline. Contents_ Elements of linear algebra, vector algebra and analytical geometry. Introduction to the analysis. Differential calculus of a function of one variable. The study of functions using derivatives. Functions of several variables. Partial derivatives. The	5		v												

		extremum of a function of two variables.															
14	Physics	Purpose: To form ideas about the modern physical picture of the world and scientific worldview, the ability to use knowledge of fundamental laws, theories of classical and modern physics. Contents_ physical fundamentals of mechanics, fundamentals of molecular physics and thermodynamics, electricity and magnetism, vibrations and waves, optics and fundamentals of quantum physics.	5		v												
15	Mathematics II	Purpose: To teach students integration methods. To teach you how to choose the right method for finding the primitive. To teach how to apply a certain integral to solve practical problems. Contents_ integral calculus of the function of one and two variables, series theory. Indefinite integrals, methods of their calculation. Certain integrals and applications of certain integrals. Improper integrals. Theory of numerical and functional series, Taylor and Maclaurin series, application of series to approximate calculations_	5		v												
16	Engineering and computer graphics	Purpose: To develop students' knowledge of drawing construction and skills in developing graphical and textual design documentation in accordance with standards. Content:	5				v				v						

		Students will study ESKD standards, graphic primitives, geometric constructions, methods and properties of orthogonal projection, Monge's projection, axonometric projections, metric tasks, types and features of connections, creating part sketches and assembly drawings, detailing, and creating complex 3D solid objects in AutoCAD.														
17	Fundamentals of the specialty	The purpose of studying the discipline is to form students' understanding of the basics of mining and metallurgical and oil and gas production, extraction, processing and transportation of minerals, machinery and equipment used in the mining and metallurgical and oil and gas industry. During the study, students will be introduced to the technological processes and the main equipment of the mining and metallurgical and oil and gas industries, the main methods of maintenance, the principles of predictive analytics of equipment.	5				v									v
18	Thermodynamics, heat transfer and thermal engineering installations	The main issues and methods for obtaining, converting, transferring and using thermal energy, the fundamental principles of operation and schemes of heat engineering installations, to teach how to evaluate and compare the energy and economic indicators of heat power plants, to effectively use the means of production in	5		v				v							v

		technological processes. The study of the physical foundations, devices, principle of operation and technical characteristics of the main and auxiliary heat and power equipment and systems.															
19	Theoretical and applied mechanics	_To involve students in the development and solution of tasks that help bridge the gap between scientific theory and engineering practice.Contents_ Theoretical mechanics, theory of mechanisms and machines. Theoretical mechanics deals with the general laws of mechanical movements of material bodies and the mechanical interactions between them. In the theory of mechanisms and machines, general methods of research, construction, and kinematics of mechanisms and machines are studied_	5		v						v						
20	Basics of hydraulics and hydraulic drives of technological machines	Application of knowledge in the field of technical fluid mechanics (hydraulics), for the calculation of hydraulic pressure systems, hydraulic machines, hydraulic and pneumatic actuators, widely used in the oil industry. Full hydraulic calculation of various hydraulic systems, hydraulic and pneumatic equipment drives. Getting the basics of knowledge in the field of hydraulics - theoretical fluid mechanics in the field of hydraulic and pneumatic actuators.	5		v								v				

21	Strength of materials	_to independently calculate structural elements, mechanisms and machine parts. Contents_ Stretching and compression. Stresses in cross sections and deformations of a straight rod. Mechanical properties of materials under tension and compression. Calculation of tensile and compressive strength and stiffness. Geometric characteristics of flat sections. Shear and torsion. Calculation of strength and torsional stiffness. The bend. Normal and tangential bending stresses_	5		v						v								
22	Metrology, standardization and technical measurements	The discipline of Metrology, standardization and technical measurements is one of the basic disciplines aimed at developing scientifically based skills for students to control, apply and meet the requirements of standards in force in the Republic of Kazakhstan in the production and repair of machine parts. Solving the problems of the basics of interchangeability and certification of engineering products. To form a system of competencies of a future specialist in the field of production and repair technologies, by studying the basics of the theory of standardization, metrology and certification to solve the tasks of professional activity.	6			v						v							

23	Construction materials processing machinery and equipment	The solution of the most important technical problems associated with the creation and development of the most economical materials, increasing the accuracy, reliability and performance of mechanisms and devices depends largely on the development of materials science and technology for producing and processing materials, concretization of knowledge about the relationship between the composition, structure and properties of materials used for management of the structure and properties of structural materials.	5			v			v								
24	Industrial economics	Purpose: To provide students with an understanding of the basic principles and factors affecting industrial economics, including the organization of production, the competitiveness of enterprises, and the impact of government policy. Content: study the structure and dynamics of industrial production, analyze the main factors affecting the efficiency of enterprises, including technological innovation, factors of production and competition. Examination of the role of public policy in industrial development and industrial safety issues.	5					v		v							
25	Bases of designing and details of cars	Purpose: to acquire knowledge of calculations and design of machine parts and assemblies, taking into account the criteria of strength, reliability and stability. Contents_	5		v				v								

		general principles of design and construction, construction of models and calculation algorithms for standard machine parts taking into account performance criteria, fundamentals of theory and methodology for calculating standard machine parts, computer technologies for designing assemblies and machine parts. Basic requirements for machine parts and assemblies_															
26	Electrotechnics and microelectronics	Electrical and magnetic circuits. Basic definitions, parameters and methods of calculation of DC electrical circuits. Analysis and calculation of linear AC circuits. Analysis and calculation of electrical circuits with nonlinear elements. Analysis and calculation of magnetic circuits. Electromagnetic devices and electrical machines. Fundamentals of electronics and electrical measurements. The element base of modern electronic devices. Semiconductor elements. Electronic equipment power supply devices. Amplifiers of electrical signals. Electronic amplifiers and generators. Elements of pulse technology. Pulse and auto-generator devices. Fundamentals of digital and microelectronics. Microprocessor tools	5		v				v								
27	Industrial safety	A complex of scientifically based constructive, technological, organizational measures aimed at	5						v	v							

		<p>minimizing the man-made impact of objects on environmental components. Forecasting, assessment of the consequences of man-made impacts on the components of the natural environment during the construction and operation of facilities. Classification, composition, sources of technogenic impact of objects. Technology of restoration and optimization of the state of components of the natural environment</p>																
28	Algorithmization and programming basics	<p>The course explores the fundamental concepts of programming: operator, variable, procedure, function, data type. The main structures of algorithms are considered, such as linear, branched, cyclic. The course examines the basic forms of data representation: strings, structures, arrays, lists. Separate topics are devoted to the creation of widely used sorting algorithms, searching for the minimum and maximum values in an array, string processing, iterative and recursive algorithms, building flowcharts of algorithms and developing programs based on them.</p>	4		v	v												
29	The dynamics and durability of technological machines	<p>Students study the criteria for calculating technological machines and structures for strength. To learn the formulation and analysis of calculation results, the ability to</p>	4							v			v					

		determine operating stresses, to master a number of accurate and approximate methods for determining the characteristics of operational loads, considering the bearing capacity of parts and structures as a random variable, to be able to calculate dynamic loads in drives and other parts of technological machines														
30	Technology of manufacturing technological machines	Mastering the discipline is based on the study of the methodology for calculating the economic efficiency of the method of obtaining blanks, normalizing operations; application of operations design methodology; methods for calculating the minimum allowances, cutting conditions, the required amount of technological equipment, methods for ensuring the specified accuracy of manufacturing parts, technological processes for the production of standard parts and assemblies of machines and equipment.	5			v						v				
31	Technical diagnostics of technological machines	The course is aimed at studying the theoretical foundations of technical diagnostics and obtaining practical skills in the use of non-destructive testing methods to assess the technical condition of technological machines and equipment; to familiarize students with the basics of the theory of technical diagnostics, types of technical condition, controlled	4										v		v	v

		parameters, technical diagnostics systems; to study the physical foundations of non-destructive testing methods for detecting and diagnosing malfunctions of technological equipment; familiarization with equipment for non-destructive testing, test methods, acquisition of practical skills															
32	Microcontroller programming	Microcontroller Programming This course is intended for students to study the current state of microprocessor and microcontroller control systems. The purpose of the course is the formation of bachelor's knowledge on the principles of building digital data processing tools, the features of the organization of the work of microprocessor devices and the use of microprocessors in control systems of technical objects. As part of the course, the student will master the microcontrollers of the AVR family. AVR command system. Means of input/output in microprocessor systems. Programming of microprocessor systems.	5		v		v										
Cycle of basic disciplines																	
Component of choice																	
33	Oil and gas production technologies	Students study the basics of well construction technology, oil and gas production. Acquisition of skills for competent choice of the method of opening productive objects, designing	5											v	v		

		the design of wells, choosing methods for influencing the productive formation, calculating the modes of operation of the "well-formation" system. The study of techniques and technologies used in the oil and gas industry, methods of construction and operation of wells, collection and preparation for transportation of oil and gas in the fields, underground gas storage. Acquisition of skills in calculating wells, the need for materials for the preparation of drilling fluid, drilling mode parameters, physical properties of oil and gas, gas well flow rates.																
34	Mining technologies	The aim of the course is to contribute to the development of scientific and technical thinking and the acquisition by students of the necessary knowledge and practical skills in the field of technology of stripping and mining operations in open development Objectives of the course: study of the level of mining and the need for them in the national economy, information about mineral deposits and the condition of their occurrence; familiarization with the methods of mining and prospects for their development; the essence of underground mining and the main mine workings; the main production processes and technical and economic indicators of mines; methods of	5								v	v						

		opening and systems development of mineral deposits; basic technological processes.															
35	Technologies of metallurgical production	The purpose of teaching the discipline is to give students in-depth knowledge about the basic theoretical and technological provisions of the production of ferrous and non-ferrous metals; the ability to solve complex technological problems; to have the skills of independent work on the organization and management of experimental studies of technological processes at existing metallurgical units and promising experimental and pilot industrial complexes. The objectives of studying the discipline are to master the general laws of processes occurring in ferrous and non-ferrous metallurgy units; to master methods for calculating the charge, material and thermal balances of the process, intensification of technological processes and control of melting; to get acquainted with promising technologies in metallurgy, including hydrometallurgy.	5									v	v				
36	Fundamentals of Scientific Research	Discipline studies the role of science in material production, economics, politics, management and in the education system and other areas of society. New tendencies in construction, as well as modern methods for solving research and	5		v											v	v

		professional problems. The current state of science, experimental research. The latest instruments and equipment for experimental research; The theoretical basis for the formation of scientific research in the field of construction, as well as legislative acts, ethical and legal norms and regulatory materials in the organization and conduct of scientific research. Methods for conducting experimental studies of various types of structures;														
37	Legal regulation of intellectual property	Purpose: the goal is to form a holistic understanding of the system of legal regulation of intellectual property, including basic principles, mechanisms for protecting intellectual property rights and features of their implementation. Content: The discipline covers the basics of IP law, including copyright, patents, trademarks, and industrial designs. Students learn how to protect and manage intellectual property rights, and consider legal disputes and methods for resolving them.	5	v							v					
38	Fundamentals of Artificial Intelligence	Purpose: to familiarize students with the basic concepts, methods and technologies in the field of artificial intelligence: machine learning, computer vision, natural language processing, etc. Contents: general definition of artificial intelligence,	5				v							v	v	

		intelligent agents, information retrieval and state space exploration, logical agents, architecture of artificial intelligence systems, expert systems, observational learning, statistical learning methods, probabilistic processing of linguistic information, semantic models, natural language processing systems.															
39	Drilling machines and complexes	The construction of equipment for drilling wells for the purpose of oil and gas production, the device and the main directions of further development of drilling machines and systems in accordance with the trends of global technical progress. Evaluating the effectiveness of machinery and equipment for choosing a rational way of their operation The technical level, ways to improve the design, methods of operation of drilling machines and systems.	5									v	v				
40	Mining machinery and equipment	Pneumatic and hydraulic drilling rigs for drilling holes and wells. Charging machines and installations. Designs of loading machines of cyclic and continuous action and excavators. Traction calculations. Machines and complexes for tunneling and cleaning works. Machines and equipment for vertical and inclined workings and shafts. Inspection and maintenance of the roof of mines and workings.	5									v	v				

41	Fundamentals of sustainable development and ESG projects in Kazakhstan	Purpose: the goal is for students to master the theoretical foundations and practical skills in the field of sustainable development and ESG, as well as to develop an understanding of the role of these aspects in the modern economic and social development of Kazakhstan. Contents: introduces the principles of sustainable development and the implementation of ESG practices in Kazakhstan, includes the study of national and international standards, analysis of successful ESG projects and strategies for their implementation in enterprises and organizations.	5	v							v					v
42	Technological lines and complexes of metallurgical production	The course provides students with the necessary knowledge about the scale of metallurgical production and the continuity of its constituent processes, patterns of construction and trends in the development of technological lines of metallurgical production, necessary for production, design and research activities. Students' mastering of technologies for obtaining various metals, starting with enrichment and ending with metalworking processes by pressure, the structure of existing technological lines and complexes of metallurgical workshops and prospects for the development of metallurgical production, the principle of choosing machines and mechanisms, determining the required number of	5								v	v				

		them for lines and complexes of metallurgical workshops															
Cycle of profile disciplines																	
University component																	
43	Installation and repair of technological machines	The acquisition by students of theoretical knowledge and practical skills on the basics of designing technological processes for the repair and restoration of worn parts, assembly units, machines and equipment; Determination of optimal modes of performance of production processes; quality control of repair of machines and equipment. Organization and engineering support of high-quality installation of equipment, methods of mechanization and automation of technological processes and rules for safe work	5					v								v	
44	Instrumentation and automation of technological machines	Formation of the future specialist knowledge of the design of devices, their purpose and principles of operation. As well as special training of engineering and technical personnel with scientific and practical knowledge in the field of operation, as it solves relevant engineering and scientific problems in the field of quality, performance properties and rational use of fuels, oils, lubricants and technical fluids.	5					v					v				v
45	Fundamentals of reliability of	The course provides students with knowledge and skills that provide a creative approach to solving problems	5										v	v			

	technological machines	of reliability and durability of technological machines and equipment necessary to increase the level of automation, reduce huge repair costs from machine downtime, and ensure safety during equipment operation. When studying disciplines, students master the issues of ensuring the reliability and durability of technological equipment; principles of rational use of technical parameters of technological machines															
46	Geomonitoring of the technical condition of technological machines	Formation of future specialist knowledge on the design of diagnostic devices, their purpose and principles of operation directly at the place of production work, the use of devices for their intended purpose, assessment of the state of equipment, as well as special training of engineering and technical personnel with scientific and practical knowledge in the field of operation, t .To. it solves topical engineering, technical and scientific problems in the field of quality, operational properties and rational use of these devices.	5				v							v			v
Cycle of profile disciplines																	
Component of choice																	
47	Oil and gas field machines and mechanisms	The design of the wellbore completed by drilling. Units of capital and current repair of wells. Equipment and tools for the overhaul and maintenance of wells. Equipment wells for various	5			v								v			

		methods of influence on the reservoir in order to increase its oil recovery. Collection system, preparation of well production. Equipment for maintaining reservoir pressure and oil displacement from productive formations															
48	Mining and transport machines	As part of the course, students study the principles of operation and design of mining and transport machines; classification and purpose of machines for mining and transportation of minerals; schematic diagrams, design features, applications and basic design characteristics of various machines for breaking, loading, transportation, fastening and other auxiliary operations; methods for determining the main structural and operational parameters of mining and transport machines, their productivity and efficiency in mining production	5			v							v				
49	Equipment for metallurgical plants	General characteristics of the mechanical equipment of an iron and steel industry. Classification of the equipment on a functioning of drives in a cycle of working hours. The crushing equipment. The common data on process of crushing. Types of crushing machines. Calculation of crushers. Chopper the equipment. The common data and classification of mills. Calculation of key parameters. The equipment of a uniform feed of	5			v							v				

		technological machines. Types, the device, calculation of key parameters. The equipment for enrichment. The necessary mechanical equipment. Calculation of key parameters. The equipment for drying concentrates															
50	Design and construction of oil and gas machines	"Design and construction of oil and gas machines" gives students the following knowledge and skills: knowledge of basic oil and gas machines, mechanisms and equipment; knowledge of the design conditions and basic requirements for oil and gas machines and equipment; knowledge of labor protection and environmental issues; ability to choose equipment according to the operating conditions of oil fields; ability to choose the operating mode of equipment, maintenance and routine repairs; the ability to perform verification calculations of load capacity, performance, pressure, temperature; skills in using scientific, technical and reference literature, determining the technical characteristics of machines and equipment and evaluating their technical and economic efficiency.	5			v						v					
51	Design and construction of mining machines	In the academic discipline the student studies the basics of computer-aided design of mining, transportation vehicles and stationary installations; methods and techniques for	5			v						v					

		developing tools for interactive documentation and tools for teamwork on the project. The fundamentals of designing and modifying parts and units of machines and installations are considered. Students get knowledge in the field of creating machines and installations, documentation design, interactive electronic technical guides.															
52	Construction of metallurgical machines	The purpose of the study: Encouraging students to make the right choice of design, stages of implementation, review and approval of design documentation; method of organization and execution of design work; methodology of designing of metallurgical machines and units. Summary: Contents and stages of development of machine-building products. The order of development, production, delivery of machines and aggregates. Forecasting developments. Calculations during projecting. General principles of construction. Requirements for the construction of machine. Principles and methods of construction. Variants of development and selection of the optimal variants. Organization of design works. The basic rules for the design of mechanisms and machine components. Construction of joints of parts. Plug-in connections: threaded, keyed, splined, etc. All-in-one connections: welded and brazed. Optimization of loading.	5			v							v				

		Analysis of the structure of mechanisms. Construction of details. Technological metallurgical equipment. Ensuring the quality of developed machines and units.															
53	Hydraulic machines and compressors in the oil and gas industry	Acquisition of solid theoretical and practical knowledge of the designs and principles of operation of hydraulic machines, compressors, widely used in the transportation of oil, petroleum products and gas through pipelines. General schemes of hydraulic machines and compressors. The principle of the volumetric, flow machines. Varieties of hydraulic and compressor machines. Theories of action and characteristics. Areas, features of application, regulation of operating modes	5			v							v				
54	Dewatering, fan and pneumatic plants	The device is technologically important and large energy consumers in the mining industry: pumps, fans and compressors of various types, the main parameters and scope of these installations. Methods of design and installation of pumping stations, fan installations for main ventilation. Pipeline networks, their device and installation, auxiliary equipment, ensuring efficient and safe operation of pumping, fan and compressor units	5			v							v				
55	Dust-gas cleaning and recycling water	Studying the course gives students an idea of modern systems of dust and gas cleaning and recycling water	5							v							v

	supply of industrial enterprises	supply of industrial enterprises. Contains basic information about the features of water supply of industrial enterprises. The systems and schemes of industrial water supply, methods and technologies of water treatment are considered, data on the design of installations for cooling recycled water and improving its quality, preventing suspension deposits and biological fouling, scale formation and corrosion in pipelines and equipment are contained.														
56	Energy-saving technologies in the oil and gas industry	Formation of knowledge, skills and abilities in energy efficiency and energy saving in the mining, metallurgical and oil and gas industries based on equipment and technologies for automation and control, mastering knowledge in the field of energy saving, mastering the principles and methods of energy saving as a set of measures or actions taken to ensure efficient use of energy resources and technological equipment during their operation. Objectives of the discipline: Familiarization with the main methods of reducing the energy intensity of industrial enterprises and the sphere of energy consumption by assessing the effectiveness of the existing energy complex, making recommendations on the correct choice of energy-saving technologies and ensuring their implementation by	5					v					v		v	

		means of automation of technological processes.																		
57	Energy-saving technologies in the mining industry	Formation of knowledge, skills and abilities in energy efficiency and energy saving in the mining, metallurgical and oil and gas industries based on equipment and technologies for automation and control, mastering knowledge in the field of energy saving, mastering the principles and methods of energy saving as a set of measures or actions taken to ensure efficient use of energy resources and technological equipment during their operation. Objectives of the discipline: Familiarization with the main methods of reducing the energy intensity of industrial enterprises and the sphere of energy consumption by assessing the effectiveness of the existing energy complex, making recommendations on the correct choice of energy-saving technologies and ensuring their implementation by means of automation of technological processes.	5						v								v		v	
58	Energy-saving technologies in the metallurgical industry	Formation of knowledge, skills and abilities in energy efficiency and energy saving in the mining, metallurgical and oil and gas industries based on equipment and technologies for automation and control, mastering knowledge in the field of energy saving, mastering the	5						v									v		v

		principles and methods of energy saving as a set of measures or actions taken to ensure efficient use of energy resources and technological equipment during their operation.																
59	Predictive technologies in the oil and gas industry	Formation of students' knowledge system in the field of theory and practice of using predictive technologies in the maintenance and repair of technological equipment and systems; Formation of skills in the use of information technology in the design of technical management systems, in solving problems of system analysis of the state of equipment and its management; Formation of skills in applying methods, system analysis, theory of knowledge to develop scientifically based solutions in solving technical problems in the operation and maintenance of technological equipment;	6					v									v	v
60	Predictive technologies in mining	Formation of students' knowledge system in the field of theory and practice of using predictive technologies in the maintenance and repair of technological equipment and systems; Formation of skills in the use of information technology in the design of technical management systems, in solving problems of system analysis of the state of equipment and its management;	6					v									v	v

		Formation of skills in applying methods, system analysis, theory of knowledge to develop scientifically based solutions in solving technical problems in the operation and maintenance of technological equipment;														
61	Predictive technologies in metallurgical production	Formation of knowledge, skills and abilities in energy efficiency and energy saving in the mining, metallurgical and oil and gas industries based on equipment and technologies for automation and control, mastering knowledge in the field of energy saving, mastering the principles and methods of energy saving as a set of measures or actions taken to ensure efficient use of energy resources and technological equipment during their operation. Objectives of the discipline: Familiarization with the main methods of reducing the energy intensity of industrial enterprises and the sphere of energy consumption by assessing the effectiveness of the existing energy complex, making recommendations on the correct choice of energy-saving technologies and ensuring their implementation by means of automation of technological processes.	6				v								v	v
62	Operation, repair and maintenance of oil	Theoretical and practical training of future specialists - mechanical engineers of oil and gas equipment on	5				v				v		v			

	and gas machines and equipment	general issues: proper operation and timely repair of machines, identification of the type of damage and wear of parts, methods of hardening parts, development of technological repair processes, selection of repair equipment and organization of repair services of oil and gas enterprises industry.														
63	Operation, repair and maintenance of mining machines and equipment	Theoretical and practical training of future specialists - mechanical engineers of mining equipment on general issues: proper operation and timely repair of machines, identification of the type of damage and wear of parts, methods of hardening parts, development of technological repair processes, selection of repair equipment and organization of repair services of oil and gas enterprises industry.	5				v					v		v		
64	Operation, repair and maintenance of metallurgical machines and equipment	Theoretical and practical training of future specialists - mechanical engineers of metallurgical equipment on general issues: proper operation and timely repair of machines, identification of the type of damage and wear of parts, methods of hardening parts, development of technological repair processes, selection of repair equipment and organization of repair services of oil and gas enterprises industry.	5				v					v		v		

65	Organization, planning and management of the repair of oil and gas machines	Forms and methods of organizing and managing the repair and maintenance of oil and gas equipment, features of the formation and organization of the work of services; basic methods of operation and repair of equipment; get acquainted with the rules for the formation of production units, their structure and the procedure for recruiting teams. Organization of production processes of structural divisions, forms and rules of interaction with third-party enterprises, specialization and cooperation in production activities. Knowledge of these features will help the specialist quickly adapt to practical activities, master the skills of conducting efficiency analysis and coordinating the activities of various departments.	5					v				v		v		
66	Organization, planning and management of the repair of mining machines	Forms and methods of organizing and managing the repair and maintenance of mining equipment, features of the formation and organization of the work of services; basic methods of operation and repair of equipment; get acquainted with the rules for the formation of production units, their structure and the procedure for recruiting teams. Organization of production processes of structural divisions, forms and rules of interaction with third-party enterprises, specialization and	5				v				v		v			

		cooperation in production activities. Knowledge of these features will help the specialist quickly adapt to practical activities, master the skills of conducting efficiency analysis and coordinating the activities of various departments.															
67	Organization, planning and management of the repair of metallurgical machines	Forms and methods of organizing and managing the repair and maintenance of metallurgical equipment, features of the formation and organization of the work of services; basic methods of operation and repair of equipment; get acquainted with the rules for the formation of production units, their structure and the procedure for recruiting teams. Organization of production processes of structural divisions, forms and rules of interaction with third-party enterprises, specialization and cooperation in production activities. Knowledge of these features will help the specialist quickly adapt to practical activities, master the skills of conducting efficiency analysis and coordinating the activities of various departments.	5					v					v			v	
68	Digitalization of production processes in oil and gas production	Formation of a system of knowledge about the main types of digital technologies in the oil and gas field, their methods of application, the benefits of use and limitations used to solve technical problems. To master	6					v								v	

		the skills of working with modern digital technologies used in the oil and gas industry. Formation of students' competencies in the use of information and end-to-end technologies.															
69	Digitalization of mining production processes	Formation of a system of knowledge about the main types of digital mining technologies, their methods of application, the advantages of use and limitations used to solve technical problems. To master the skills of working with modern digital technologies used in mining. Formation of students' competencies in the use of information and end-to-end technologies.	6				v								v		
70	Digitalization of production processes in metallurgical production	Formation of a system of knowledge about the main types of digital technologies in the oil and gas field, their methods of application, the benefits of use and limitations used to solve technical problems. To master the skills of working with modern digital technologies used in the oil and gas industry. Formation of students' competencies in the use of information and end-to-end technologies.	6				v								v		

5. Curriculum of the educational program



KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I.SATBAYEV



APPROVED
Chairman of the Management Board
Rector of KazNRTU named after K.Satbayev
M.M. Begentaev
2024

CURRICULUM
of Educational Program on enrollment for 2024-2025 academic year

Educational program 6B07132 - "Predictive technologies and machine diagnostics"
Group of educational programs B064 - "Mechanics and metal working"

Form of study: full-time		Duration of study: 4 years				Academic degree: Bachelor of Engineering and Technology										
Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	classroom volume of lek/lab/pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters								
								I course		II course		III course		IV course		
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester	7 semester	8 semester	
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)																
M-1. Module of language training																
LNG108	English language	GED, RC	10	300	0/0/6	210	E	5	5							
LNG 104	Kazakh (Russian) language	GED, RC	10	300	0/0/6	210	E	5	5							
M-2. Module of physical training																
KPK 101-104	Physical Culture	GED, RC	8	240	0/0/8	120	Difference	2	2	2	2					
M-3. Information technology module																
CSE 677	Information and Communication Technologies (in English)	GED, RC	5	150	2/1/0	105	E				5					
M-4. Module of socio-cultural development																
HUM137	History of Kazakhstan	GED, RC	5	150	1/0/2	105	GE		5							
HUM132	Philosophy	GED, RC	5	150	1/0/2	105	E				5					
HUM120	Module of socio-political knowledge (sociology, political science)	GED, RC	3	90	1/0/1	60	E				3					
HUM134	Module of socio-political knowledge (culturology, psychology)	GED, RC	5	150	2/0/1	105	E			5						
M-5. Module of anti-corruption culture, ecology and life safety base																
HUM136	Fundamentals of anti-corruption culture and law	GED, CCH	5	150	2/0/1	105	E				5					
MNG489	Fundamentals of Economics and Entrepreneurship															
MSM500	Scientific research methods															
MNG564	Basics of Financial Literacy															
CH 656	Ecology and life safety															
CYCLE OF BASIC DISCIPLINES (BD)																
M-6. Module of physical and mathematical training																
MAT 101	Mathematics I	BD, UC	5	150	1/0/2	105	E	5								
PHY 468	Physics	BD, UC	5	150	1/1/1	105	E	5								
MAT 102	Mathematics II	BD, UC	5	150	1/0/2	105	E		5							
M-7. Basic training module																
GEN 429	Engineering and computer graphics	BD, UC	5	150	1/0/2	105	E	5								
TEC606	Basics of the specialty	BD, UC	5	150	2/0/1	105	E	4								
TEC577	Thermodynamics, heat transfer and thermal engineering installations	BD, UC	5	150	2/0/1	105	E			5						
GEN411	Theoretical and applied mechanics	BD, UC	5	150	2/1/0	105	E			5						
TEC461	Fundamentals of hydraulics and hydraulic drives of technological machines	BD, UC	5	150	2/0/1	105	E				5					
GEN408	Strength of materials	BD, UC	5	150	1/1/1	105	E				5					
TEC608	Metrology, standardization and technical measurements	BD, UC	5	150	2/0/2	105	E			6						
TEC460	Structural materials of technological machines and equipment	BD, UC	5	150	2/1/0	105	E		5							
NSE143	Economics of industry	BD, UC	5	150	2/0/1	105	E							5		
GEN125	Basics of design and machine parts	BD, UC	5	150	1/1/1	105	E			5						
ELC103	Electrotechnics and microelectronics	BD, UC	5	150	2/1/0	105	E				5					
TEC578	Industrial Safety	BD, UC	5	150	2/0/1	105	E							5		
CSE554	Algorithmization and Programming	BD, UC	4	120	1/1/1	75	E					4				
TEC583	Oil and gas production technologies	BD, CCH	5	150	2/0/1	105	E				5					
TEC584	Mining technologies															
TEC585	Technologies of metallurgical production															
PED122	Fundamentals of Scientific Research															
MNG562	Legal regulation of intellectual property															
CSE831	Fundamentals of Artificial Intelligence															
TEC555	Dynamics and strength of technological machines															
PED189	Manufacturing technology of technological machines															
TEC607	Technical diagnostics of technological machines															
AUT184	Microcontroller programming															
TEC485	Drilling machines and complexes	BD, CCH	5	150	2/0/1	105	E				5					
TEC483	Technological lines and complexes of metallurgical production															
MNG563	Fundamentals of sustainable development and ESG projects in Kazakhstan															
PED137	Mining machinery and equipment	BD, UC	2		2/0/1		E									
AAP173	Educational practice															
CYCLE OF PROFILE DISCIPLINES (PD)																
M-8. Module of professional activity																
TEC586	Installation and repair of technological machines	PD, UC	5	150	2/0/1	105	E								5	
PED193	Instrumentation and automation of technological machines	PD, UC	5	150	2/0/1	105	E				5					
TEC587	Fundamentals of Reliability of Technological Machines	PD, UC	5	150	2/0/1	105	E					5				
TEC588	Geomonitoring of the technical condition of technological machines	PD, UC	5	150	2/0/1	105	E									5
TEC479	Oil and gas field machines and mechanisms	PD, CCH	5	150	2/0/1	105	E									
TEC429	Mining and transport machines															
PED149	Equipment for metallurgical plants															
TEC590	Design and construction of oil and gas machines															
TEC591	Design and construction of mining machines															

