Institute _____ **Energy and Mechanical engineering** _____

Department __ **Mechanical engineering** _____

EDUCATIONAL PROGRAM

8D07111 - Digitalization of engineering manufacturing

the name of educational program

Code and name field of education:
8D07-Engineering, manufacturing and civil engineering
Code and classification direction of personnel training:
8D071-Engineering and engineering trades
Group of educational programs:
D103-Mechanics and metal working
EP purpose: 8
EP type: 8
Period of study: 3 years
Volume of the credits: 180

Almaty 2023

Educational program 8D07111 - Digitalization of engineering manufacturing
(the name of educational program)

was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Minutes 3 dated « 27 » October 2022.

was reviewed and recommended for approval at the meeting of K.I. Satbayev KazNRTU Educational and Methodological Council

Minutes 2 dated « 21 » October 2022.

Educational program 8D07111 - Digitalization of engineering manufacturing
(the name of educational program)
code and name of the

educational program developed by the academic committee in the direction «8D071-Engineering and engineering trades»

Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairperson of Academic Committee:				
Nugman E.Z.	Doctor PhD	Head of the Department of "Mechanical Engineering"	NAO KazNRTU named after K.I. Satpayev, Institute of Energy and Mechanical Engineering	
Teaching staff:				
Kerimzhanova M.F.	Candidate of Technical Sciences, Associate Professor	Professor	Department of Mechanical Engineering	
Issametova M.E.	Candidate of Technical Sciences	Assoc. Professor	Department of Mechanical Engineering	
Uderbayeva A.E.	Doctor PhD	Assoc. Professor	Department of Mechanical Engineering	
Employers:				
Azimbekov M. K.		Director	LLP "Zhaken Kalsha"	
Students				
Ibraim A.S.		3nd year doctoral student	Department of "Mechanical Engineering"	

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List of abbreviations and designati

ECTS	European Credit Transfer and Accumulation System
BD	Basic disciplines
HEI	Higher education institution
SMSE	State mandatory standard of education
KazNRTU	K. I. Satpayev Kazakh National Research Technical University
MEP	Modular educational program
NJsC	Non-profit joint stock Company
RWDS	Research work of a doctoral student
EP	Educational program
PD	Profile disciplines
WC	Working curriculum
IWDS	Independent work of a doctoral student
EMC	Educational and Methodological Council
AC	Academic council

1 Description of educational program

A doctoral student in the field of training "Digitalization of engineering manufacturing" should be prepared to solve professional tasks in accordance with the profile orientation of the doctoral program and types of professional activity:

design and engineering activities:

- analysis of the state of the scientific and technical problem and determination of the goals and objectives of the design of instrument systems based on the study of world experience;
- making decisions based on the results of calculations on projects and the results of technical and economic and functional cost analysis of the effectiveness of the designed engineering systems;

production and technological activities:

- development of methods for conducting theoretical and experimental research on the analysis, synthesis and optimization of the characteristics of materials used in mechanical engineering;
- solving economic and organizational problems of technological preparation of production of machine systems and the choice of systems to ensure environmental safety of production;

research activities:

- the construction of mathematical models for the analysis and optimization of research objects, the choice of a numerical method for their modeling or the development of a new algorithm for solving the problem;
- development and optimization of field experimental studies of machine systems, taking into account the criteria of their reliability;
- preparation of scientific and technical reports, reviews, publications based on the results of the research carried out;
- application of the results of research activities and the use of intellectual property rights;

organizational and managerial activities:

- finding optimal solutions when creating high-tech products, taking into account the requirements of quality, cost, deadlines, competitiveness, life safety, as well as environmental safety;
- support of a unified information space for enterprise planning and management at all stages of the life cycle of manufactured products;
- development of plans and programs for the organization of innovative activities at the enterprise.
- deep knowledge and understanding of fundamental phenomena in their field of science.

scientific and pedagogical activity:

- participation in the development of programs of academic disciplines and courses based on the study of pedagogical, scientific, technical and scientific-methodical literature, as well as the results of their own professional activities;
- participation in the formulation and modernization of individual laboratory work and workshops in professional disciplines;

- conducting training sessions with students, participating in the organization and management of their practical and research work;

- application and development of new educational technologies, including computer and distance learning systems.

Based on the theoretical and practical knowledge obtained, a doctoral student of technical sciences under the educational program 8D07111 – "Digitalization of machine-building production" forms professional competencies and must:

have an idea of:

- the main stages of development and change of technological patterns in science and technology;

- on the subject, ideological and methodological specifics of the natural (social, humanitarian, economic) sciences;

- about scientific schools of the relevant branch of knowledge, their theoretical and practical developments;

- about scientific concepts of world and Kazakh science in the relevant field;

- on the mechanism of implementation of scientific developments in practical activities;

- on the norms of interaction in the scientific community;

- about the pedagogical and scientific ethics of a research scientist;

know and understand:

- current trends, trends and patterns of development of Russian science in the context of globalization and internationalization;

- methodology of scientific knowledge;

- achievements of world and Kazakh science in the relevant field;

- (to realize and accept) the social responsibility of science and education;

- perfect foreign language for scientific communication and international cooperation;

be able to:

- to organize, plan and implement the process of scientific research;

- analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions;

- analyze and process information from various sources;

- conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis;

- generate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge;

- to choose and effectively use modern research methodology;

- plan and predict your further professional development;

have skills:

- critical analysis, evaluation and comparison of various scientific theories and ideas;

- analytical and experimental scientific activities;

- planning and forecasting of research results;

- public speaking and public speaking at international scientific forums,

conferences and seminars;

- scientific writing and scientific communication;
- planning, coordination and implementation of scientific research processes;
- a systematic understanding of the field of study and demonstrate the quality and effectiveness of the selected scientific methods;
- participation in scientific events, fundamental scientific domestic and international projects;
- leadership management and team management;
- responsible and creative attitude to scientific and scientific-pedagogical activity;
- conducting patent search and experience in the transfer of scientific information using modern information and innovative technologies;
- protection of intellectual property rights to scientific discoveries and developments;
- free communication in a foreign language;

be competent:

- in the field of scientific and scientific-pedagogical activity in the conditions of rapid updating and growth of information flows;
- in carrying out theoretical and experimental scientific research;
- in the formulation and solution of theoretical and applied problems in scientific research;
- to conduct a professional and comprehensive analysis of problems in the relevant

field;

- in matters of interpersonal communication and human resource management;
- in matters of university training of specialists;
- in the examination of scientific projects and research;
- in ensuring continuous professional growth.

2 The purpose and objectives of additional educational program

EP purpose:

Training of competitive, qualified personnel with high spiritual and moral qualities, ready to solve scientific and design, research, scientific and pedagogical problems in the conditions of digitalization of the machine-building complex.

EP tasks:

- preparation of a scientific and pedagogical specialist for continuous self-improvement and self-development, mastering new knowledge, skills and abilities in innovative areas of digitalization of machine-building production;
- preparation of doctoral students for a successful career in the field of digitalization of machine-building production, private, public and public organizations, educational institutions, through teaching disciplines that will

provide the profile knowledge, tools, skills and skills necessary in a competitive environment;

- training of scientific and pedagogical personnel, based on the diversity and dynamism of the catalog of elective disciplines of the curriculum, with a predominance of practical skills in competencies, capable of performing professional functions within one or more types of activities based on the final results of training, taking into account the specifics of these activities, market requirements for organizational management, professional competencies;

- training of scientific and pedagogical personnel as a competitive specialist in the field of digitalization of machine-building production that meets international standards and allows Kazakhstan to integrate into the global educational space.

3 Requirements for evaluating the learning outcomes of an educational program

As a result of mastering the EP modules, students develop the knowledge, skills and abilities necessary to carry out all types of professional activities in the field of mechanical engineering, develop training skills to carry out further training with a high degree of independence, that is, the formation of professional, communication and key competencies that meet the requirements of employers.
Qualification awarded to the graduate Doctor of Philosophy PhD in EP 8D07111 – "Digitalization of engineering manufacturing"

4 Passport of the educational program

4.1 General information

№	Field name	Note
1	Code and name field of education	8D07- Engineering, manufacturing and civil engineering
2	Code and classification direction of personnel training	8D071- Engineering and engineering trades
3	Group of educational programs	D103- Mechanics and metal working
4	Name of the educational program	8D07111-Digitalization of engineering manufacturing
5	Short description of the educational program	The professional activity of the doctoral student is aimed at developing a strategy and design goals, analyzing technical information, modeling objects and processes using computer-aided design software packages, conducting research in the field of additive manufacturing. Doctoral students will gain knowledge of effective methods of solving problems of technology, economics and management; they will acquire the skills and abilities of mathematical, physical and computer modeling of additive technological processes, conducting research with the search for optimal solutions when creating competitive products
6	EP purpose	Training of competitive, qualified personnel with high spiritual and moral qualities, ready to solve scientific and design, research, scientific and pedagogical problems in

		the conditions of digitalization of the machine-building complex
7	EP type	New EP
8	Level on NQF	8
9	Level on SQF	8
10	EP distinctive features	No
11	List of competencies of the educational program:	- Ability to analyze physico-chemical phenomena occurring in additive manufacturing, features of applied methods of additive technologies in the field of mechanical engineering; - The ability to apply modeling and experimental research methods for the development and improvement of additive manufacturing; - The ability to design optimal methods for improving the productivity, accuracy, quality and reliability of automated process equipment and tooling; - Ability to participate in international and domestic research projects and works on the application of additive technologies in the production of blanks and machine parts; - The ability to build mathematical models using modern applied software tools in solving practical problems of organizing the selection of technologies, technological equipment, diagnostics and software testing of technological processes; - Readiness for scientific and teaching activities in the field of professional disciplines of additive manufacturing.
12	Learning outcomes of the educational program:	ON1 To analyze scientific and technical and popular scientific texts, the results of scientific and experimental research with the preparation of scientific and technical reports, reviews and developments on topical issues of digital machine-building production ON2 Participate in the formulation of scientific and scientific-educational tasks, conducting theoretical and experimental research based on the principles of the organization of scientific research and the choice of research methods in the conditions of digitalization of machine-building production ON3 Apply innovative business models, business processes, computer technologies in the preparation, design and production of digital factories in scientific research and professional activity ON4 Solve design, engineering, technological, organizational and managerial tasks of machine-building production on the basis of modern optimization methods using targeted software ON5 To analyze scientific and experimental research based on a systematic approach to the design, production and organization of machine-building

		production, methods of forecasting, optimization and decision-making in conditions of uncertainty ON6 To apply methods of artistic design, technical aesthetics of industrial equipment, modern industrial design technologies when conducting scientific, technical and experimental research ON7 To make decisions in the field of life cycle management of engineering products based on industrial production modeling, advanced computer-aided design software packages, energy and resource conservation principles ON8 Synthesize new knowledge and technologies based on the analysis of virtual and augmented reality systems, computer modeling methods in the field of digitalization of machine-building production.
13	Form of training	daytime
14	Period of study	3 years
15	Volume of the credits	180
16	Language of education	russian
17	The awarded academic degree	Doctorate
18	Developer(s) and authors:	The educational program was developed by the academic committee in the direction "8D071-Engineering and Engineering"

4.2 The relationship between the achievability of the formed learning outcomes according to the educational program and academic disciplines

№	Name of discipline	Short description of discipline		Number of credits	The formed educational outcomes (codes)							
					ON1	ON 2	ON 3	ON 4	ON 5	ON 6	ON 7	ON 8
		Cycle of basic disciplines University component										
1	Academic writing	The course is aimed at developing academic writing skills and writing strategies for doctoral students in the field of engineering and natural sciences. The course focuses on the basics and general principles of academic writing for; writing effective sentences and paragraphs; using tenses in scientific literature, as well as styles and punctuation; writing abstracts, introductions, conclusions, discussions, conclusions, literature and resources used; quoting in the text; preventing plagiarism, and making presentations at a conference.		5	v							
2	Research methods	The course contributes to the formation of knowledge about scientific research, methods and methodology of scientific research, methods of collecting and processing scientific data, principles of organization of scientific research, methodological features of modern science, ways of development of science and scientific research, the role of technical sciences, computer science and engineering research in modern science. The discipline examines the structure of technical sciences, the application of general scientific, philosophical and special methods of scientific research in theory and in practice.		5		v						
		Cycle of basic disciplines Elective component										
3	Virtual Manufacturing	The course is aimed at developing theoretical knowledge and practical skills in the field of virtual (VR) and augmented (AR) reality technologies. The discipline studies the history of technology development; the scope of Yet Another Reality (Another Reality); market development trends, presentation of analytical materials on the AR/VR market. Gadgets, varieties and features; analysis of existing devices for demonstrating realities; platforms and software; features of projects with augmented and virtual reality technologies.		5							v	
4	Advanced Digital Factory	The course is aimed at forming a system of knowledge in the field of new business models, business processes and technologies in high-tech industries.The discipline studies the history, causes and consequences of industrial revolutions, global initiatives and programs aimed at the development of Industry 4.0.; modern information technologies, digital platforms for development and		5				v				

		production management, as well as "digital twins of the product of the production process" (Digital Twins). Computer engineering, digital design capabilities, building a digital factory.										
		Cycle of profile disciplines Component of choice										
5	Advanced Decision Analysis	In the course, students acquire knowledge and skills in conducting system analysis in research; designing technological processes and equipment, in production management.The discipline studies the essence of system analysis, properties of systems, methods of finding solutions. The basic principles and trends in the design of machines, a systematic approach to the operation of machines and equipment, a systematic approach to production management; methods of forecasting the development of systems; methods of optimizing technical solutions; decision-making in conditions of uncertainty are considered; quality management systems		5			v					
6	Advanced Design of Industrial Experiments	The course acquires knowledge in the field of design, the history of its development and the study of modern design as the basis for creating an object of applied or industrial purpose. The discipline studies technical aesthetics and industrial design, the history of technology and the arts; the main areas of design; graphic design, transport design; American industrial design. Construction in industrial design, fundamentals of artistic design in engineering, quality and technical aesthetics of production machines are considered. Computer technologies and modern industrial design.		5					v			
7	Advanced Optimization	The course is aimed at developing students' ability and willingness to solve design and technological problems in mechanical engineering using advanced optimization methods. The basic concepts of optimization theory, the process of optimization design in CAD are studied; Methods of nonlinear optimization, tools for analyzing the properties of models in CAD; optimization of process parameters by optimization methods. Application for practical solutions software Creo Parametric, SolidWorks, etc.		5						v		
8	Advanced Systems of Manufacturing	The course is aimed at the formation of knowledge about the state, problems and prospects of the effective organization of technological processes in the branches of the material sphere. The discipline studies modern production technologies: metallurgical, machine-building, transport, information. The types of technologies and their impact on the life cycle are considered; automation of the technological process in mechanical engineering; fundamentals of technology and the construction of a lean production process; methodology of the theory of constraints.		5								v

5 Curriculum of the educational program

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

SATBAYEV UNIVERSITY

APPROVED
Chairman of the Management Board-
Rector of Kazntu named after K.Satpayev
M.M. Begentaev
2022 y.

CURRICULUM
of Educational Program on enrollment for 2023-2024 academic year

Educational program 8D07111 - "Digitalization of machine-building production"
Group of Educational programs D103 - "Mechanics and metalworking"

Form of study: full-time | Duration of study: 3 year | Academic degree: Doctor of Philosophy (PhD)

Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	Classroom amount lec/lab/pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters					
								1 course		2 course			
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester
CYCLE OF BASIC DISCIPLINES (BD)													
M-1. Technical training module (university component)													
MET322	Scientific research methods	BD UC	5	150	2/0/1	105	E	5					
LNG305	Academic writing	BD UC	5	150	0/0/3	105	E	5					
Component of choice													
MSM307	Virtual production	BD CCH	5	150	2/0/1	105	E	5					
MSM306	Advanced Digital factory												
CYCLE OF PROFILE DISCIPLINES (PD)													
M-2. Digital Engineering Module (component of choice)													
IND319	Advanced optimization	PD CCH	5	150	2/0/1	105	E	5					
IND311	Advanced production systems												
IND317	Advanced design of industrial experiments	PD CCH	5	150	2/0/1	105	E	5					
IND321	Advanced solution analysis												
M-3. Practice-oriented module													
AAP350	Pedagogical practice	BD UC	10						10				
AAP355	Research practice	PD UC	10							10			
M-4. Experimental research module													
AAP336	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	5					5					
AAP347	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	40						20	20			
AAP356	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	60								30	30	
AAP348	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	18										18
M-5. Module of final attestation													
ECA303	Writing and defending a doctoral dissertation	FA	12										12
	Total based on UNIVERSITY:							30	30	30	30	30	30
								60		60		60	

Number of credits for the entire period of study

Cycle code	Cycles of disciplines	Credits			
			university component (UC)	component of choice (CCH)	Total
BD	Cycle of basic disciplines		20	5	25
PD	Cycle of profile disciplines		10	10	20
	Total for theoretical training:	*0*	*30*	*15*	*45*
	RWDS				*123*
FA	Final attestation	12			12
	TOTAL:	12	30	15	180

Decision of the Academic Council of Kazntu named after K.Satpayev. Protocol № 3 от "17" 10 2022 y.
Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol № 2 от "31" 10 2022 y.
Decision of the Academic Council of the Institute E&ME. Protocol № 2 от "11" 10 2022 y.

Vice-Rector for Academic Affairs _____ B. A. Zhautikov
E&ME Institute Director _____ K.Yelemessov
ME Department Head _____ E.Nugman
Representative of the Council for EP from Employers _____ M.Azimbekov