

**NJSC «Kazakh National Research Technical University named after K.I. Satpayev»
Institute of Industrial Engineering
Department of "Machine-tool building, materials science and technology of machine-building production"**

CURRICULUM PROGRAM

«DIGITALIZATION OF ENGINEERING MANUFACTURING» PhD Doctor of Philosophy

on the basis of the following specialties of the invalidated Classifier of specialties:
6D071200 - Mechanical engineering, 6D073800 - Technology of material processing by pressure

1st edition

in accordance with the State Educational Standard of Higher Education 2018

Almaty 2019

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The program was drawn up and signed by the parties

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От работодателей - сопредседатель Консультативного совета ИПИ,
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Approved at a meeting of the Educational and Methodological Council of the Kazakh National Research Technical University named after K.I. Satpayev. Protocol №3 from 19.12.2018

Qualification:

Level 8 of the National Qualifications Framework:

8D071 Engineering and Engineering business (Doctorate):

8D0710112- Digitalization of engineering manufacturing

Professional competencies: in the field of research methodology; in the field of scientific and scientific-pedagogical activities in higher educational institutions; in matters of modern educational technologies; in the implementation of scientific projects and research in the professional field; in ways to ensure constant updating of knowledge, expansion of professional skills and abilities.

Ability to critically analyze and evaluate modern scientific achievements, generate new ideas when solving research and practical problems, including in interdisciplinary fields; the ability to design and carry out complex research, including interdisciplinary, based on a holistic systemic scientific worldview using knowledge in the field of history and philosophy of science; willingness to participate in the work of Kazakhstani and international research teams to solve scientific and scientific and educational problems; readiness to use modern methods and technologies of scientific communication in the

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state and foreign languages; the ability to follow ethical standards in professional activities; the ability to plan and solve problems of their own professional and personal development.

Brief description of the program:

1. Objectives

training of a highly qualified specialist in science, capable of forming his own scientific direction in the future;

preparation of scientific and pedagogical personnel for continuous self-improvement and self-development activities, 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 digitalization of engineering production, private, public and state organizations, educational institutions, through teaching disciplines that will provide profiling knowledge, tools, skills and abilities required 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 learning outcomes, taking into account the specifics of these types of activities, market requirements for organizational, managerial, professional competencies;

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

2. Types of work

- design and engineering;
- production and technological;
- research;
- organizational and managerial;
- scientific and pedagogical.

A doctoral student in the direction of training "Digitalization of engineering manufacturing" should be prepared to solve professional problems in accordance with the profile direction of the doctoral program and types of professional activities:

design and engineering activities:

- analysis of the state of the scientific and technical problem and the definition of goals and objectives for the design of instrument systems based on the study of world experience;

- decision-making based on the results of calculations for projects and the results of the technical-economic and functional-cost analysis of the effectiveness of the designed machine-building 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 the production of machine systems and the choice of systems for ensuring the environmental safety of production;

research activities:

- 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 research performed;

- application of the results of research activities and the use of rights to objects of intellectual property;

organizational and management activities:

- finding optimal solutions in the creation of science-intensive 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 planning and enterprise management at all stages of the life cycle of manufactured products;

- development of plans and programs for organizing 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 organization and modernization of individual laboratory works 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.

3. Objects of professional activity

- teaching activities in higher educational institutions according to the profile of training;

- research activities in higher educational institutions and scientific organizations according to the profile of training;
- professional activity in the field of digitalization of engineering production, requiring highly qualified personnel;
- administrative and organizational activities in higher educational institutions and scientific organizations according to the profile of training.

PASSPORT OF THE EDUCATIONAL PROGRAM

1 Scope and content of the program

The educational program for the preparation of a Doctor of Philosophy (PhD) has a scientific and pedagogical focus and involves fundamental educational, methodological and research training and in-depth study of problems and various processes in the relevant areas of science for the system of higher and postgraduate education and the scientific sphere.

The educational program for the preparation of a doctor in the profile assumes fundamental educational, methodological and research training and in-depth study of problems and various processes in the relevant areas of science for the branches of the national industry and economy, the social sphere: education, medicine, law, art, economics, business administration and areas of national security and military affairs.

Educational programs for doctoral studies in terms of vocational training are developed on the basis of studying the experience of foreign universities and research centers that implement accredited training programs for PhD doctors or doctors by profile.

The content of the educational program of specialized doctoral studies is established by the university independently.

The main criterion for the completeness of the educational process for the preparation of doctors of philosophy (PhD) (doctor in the profile) is the mastering of at least 180 academic credits by a doctoral student, including all types of educational and scientific activities.

The term of study in doctoral studies is determined by the amount of acquired academic credits. Upon mastering the established amount of academic credits and achieving the expected learning outcomes for obtaining a Ph.D. degree or by profile, the doctoral educational program is considered fully mastered and completed with the successful defense of a doctoral dissertation prepared in compliance with the existing rules.

Training of personnel in doctoral studies is carried out on the basis of educational programs in two directions:

- 1) scientific and pedagogical with a training period of at least three years;
- 2) specialized with a training period of at least three years.

EP content

The content of the EP "Digitalization of machine-building production" within the framework of specialties 6D071200 - Mechanical engineering, 6D073800 - The technology of processing materials by pressure is implemented in accordance with the credit technology of education and is carried out in the state and Russian languages.

The EP allows you to successfully implement the principles of the Bologna Process. Based on the choice and independent planning of the sequence of study

disciplines by undergraduates, they independently form their individual curriculum (IEP) for each semester according to the Working curriculum of the specialty and the Catalog of elective disciplines.

Objectives of the educational program:

- the direction of its activities to contribute to the development of a knowledge-based society by providing educational programs in the system of lifelong education;
- development of students through research activities, critical thinking, the development of professionally oriented skills and abilities;
- the use of highly professional experience in teaching doctoral students in a variety of educational environments;
- training a new competitive generation of technicians for the labor market;
- developing an environment that welcomes and supports people from different cultures, and creating an atmosphere of pursuit of knowledge, academic integration and intellectual motivation;
- carrying out research work, conducting educational activities based on the best world practice, and developing its own school for training specialists;
- development of cooperation "university-industry" to meet the labor market requirements for technical specialists, to improve the quality of educational programs for training specialists for the national industry and the economy and business sector;
- development of additional educational and training programs using multimedia and new teaching technologies for organizing learning on the basis of lifelong learning;
- establishing partnerships with other universities, organizations in order to improve the quality of education, to support technical and cultural ties.

1 Requirements for applicants

Persons with a Master's degree and work experience of at least 1 (one) year or who have completed residency training are admitted to doctoral studies.

Enrollment in the number of doctoral students is carried out by the admissions committees of universities and scientific organizations based on the results of the entrance exam for groups of doctoral studies and a certificate confirming proficiency in a foreign language in accordance with common European competences (standards).

When enrolling in universities, doctoral students independently choose an educational program from the corresponding group of educational programs.

The enrollment of persons for the targeted training of doctors of philosophy (PhD) under the state educational order is carried out on a competitive basis.

The procedure for admitting citizens to doctoral studies is established in accordance with the "Standard rules for admission to training in educational organizations that implement educational programs of postgraduate education."

The formation of a contingent of doctoral students is carried out by placing a state educational order for the training of scientific and pedagogical personnel, as well as by

paying for training at the expense of citizens' own funds and other sources. The state provides citizens of the Republic of Kazakhstan with the right to receive, on a competitive basis, in accordance with the state educational order, free postgraduate education, if they receive education of this level for the first time.

At the "entrance" the doctoral student must have all the prerequisites necessary for mastering the relevant professional doctoral curriculum. The list of required prerequisites is determined by the higher education institution independently.

In the absence of the necessary prerequisites, the doctoral student is allowed to master them on a paid basis. In this case, doctoral studies begin after the doctoral student has fully mastered the prerequisites.

3 Requirements for Completion and Diploma

Persons who have mastered the educational program of doctoral studies and defended their doctoral dissertation, with a positive decision of the dissertation councils of universities with a special status or the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, based on the results of the examination, are awarded the degree of Doctor of Philosophy (PhD) or Doctor of Science in profile and issued a state diploma with an attachment (transcript).

Persons who have received a PhD degree, in order to deepen scientific knowledge, solve scientific and applied problems on a specialized topic, perform a postdoctoral program or conduct research under the guidance of a leading scientist of the selected university.

3.1 Requirements for key competencies of doctoral graduates:

1) *have an idea:*

- about the main stages of development and the change of paradigms in the evolution of science;
- 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;
- on the scientific concepts of world and Kazakh science in the relevant field;
- on the mechanism of implementation of scientific developments in practice;
- about the norms of interaction in the scientific community;
- about the pedagogical and scientific ethics of the scientist-researcher;

2) *know and understand:*

- modern trends, directions and patterns of development of domestic science in the context of globalization and internationalization;
- methodology of scientific knowledge;
- achievements of world and Kazakh science in the relevant field;
- (to understand and accept) the social responsibility of science and education;
- perfect foreign language for scientific communication and international cooperation;

3) *be able 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;
- to conduct an 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;
- to plan and predict their further professional development;

4) *have skills:*

- critical analysis, assessment and comparison of various scientific theories and ideas;
- analytical and experimental scientific activities;
- planning and forecasting research results;
- oratory and public speaking at international scientific forums, conferences and seminars;
- scientific writing and scientific communication;
- planning, coordinating and implementing 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 leadership;
- responsible and creative attitude to scientific and scientific-pedagogical activities;
- conducting patent search and experience in transferring scientific information using modern information and innovative technologies;
- protection of intellectual property rights to scientific discoveries and developments;
- free communication in a foreign language;

5) *be competent:*

- in the field of scientific and scientific-pedagogical activity in conditions of rapid renewal 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;
- in conducting a professional and comprehensive analysis of problems in the relevant area;
- 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 constant professional growth.

3.2 Requirements for research and development of a student under the PhD program:

- 1) compliance with the main problems of the educational program of doctoral studies, on which the doctoral dissertation is being defended;
- 2) is relevant and contains scientific novelty and practical significance;
- 3) is based on modern theoretical, methodological and technological achievements of science and practice;
- 4) is based on modern methods of data processing and interpretation using computer technology;
- 5) carried out using modern scientific research methods;
- 6) contains research (methodological, practical) sections on the main protected provisions.

3.3 Requirements for the organization of practices:

The practice is carried out with the aim of developing practical skills in scientific, scientific, pedagogical and professional activities.

The educational program of doctoral studies includes:

- 1) teaching and research practice - for students of the Ph.D. program;
- 2) industrial practice - for students under the program of specialized doctoral studies.

During the period of teaching practice, doctoral students, if necessary, are involved in conducting classes in bachelor's and master's degrees.

The research practice of a doctoral student is carried out with the aim of studying the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as consolidating practical skills, applying modern research methods, processing and interpreting experimental data in the dissertation research.

The industrial practice of a doctoral student is carried out in order to consolidate the theoretical knowledge gained in the learning process and improve the professional level.

The content of research and industrial practice is determined by the topic of the doctoral dissertation.

4 Working curriculum of the educational program

4.1. 3 years of study

Year of study	The code	Name of the discipline	Component	Credits		Lec/lab/pr	Prerequisites	The code	Name of the discipline	Component	Credits		Lec/lab/pr	Prerequisites		
				ECTS	RK						ECTS	RK				
1	1 semester							2 semester								
		Electives	БД ВК	5	3				Research work of a doctoral student, including an internship and the implementation of a doctoral dissertation	НИРД	19	5				
		Electives	БД КВ	5	3				Pedagogical practice	БД	11	11				
		Electives	ПД ВК	5	3											
		Electives	ПД КВ	5	3											
		Electives	ПД ВК	5	3											
		Electives	ПД КВ	5	3											
	Total:			30	18			Total:			30	16				
2	3 semester							4 semester								
		Research work of a doctoral student, including an internship and the implementation of a doctoral dissertation	НИРД	18	4				Research work of a doctoral student, including an internship and the implementation of a doctoral dissertation	НИРД	30	7				
		Research practice	ПД	12	3											
	Total:			30	7			Total:			30	7				
2	5 semester							6 semester								
		Research work of a doctoral student, including an internship and the implementation of a doctoral dissertation	НИРД	30	7				Research work of a doctoral student, including an internship and the implementation of a doctoral dissertation	НИРД	18	4				
									Writing and defending a doctoral dissertation	ИА	12	4				
	Total:			30	7			Total:			30	8				
Overall:													180	63		

DOCTORATE DISCIPLINE CATALOG

Educational program "Digitalization of engineering manufacturing"

Study period: 3 years

Optional Components - 12 Credits					
	Code	Name of disciplines	Credits	Lec/lab/pr	semester
	ISO	Optimal machine design	3	2/0/1	1
	ISO	Digital Manufacturing Design	3	2/0/1	1
	MCH	3D scanning and digitization	3	2/0/1	1
	MCH	Photonics and advanced laser systems and technologies	3	2/0/1	1
	MCH	Design and operation of machines and equipment for gas and plasma atomization	3	2/0/1	1
	MCH	Operation of plants for additive manufacturing	3	2/0/1	1
	ISO	Digital Manufacturing Risk Management	3	2/0/1	1
	MCH	Additive manufacturing	3	2/0/1	1

5 Descriptors of the level and amount of knowledge, abilities, skills and competencies

The third level descriptors within the Comprehensive Qualifications Framework of the European Higher Education Area (EC-EHEA) reflect learning outcomes that characterize the student's abilities:

- 1) demonstrate a systematic understanding of the field of study, mastering the skills and research methods used in this area of digitalization of engineering production;
- 2) demonstrate the ability to think, design, implement and adapt the essential research process with a scientific approach;
- 3) contribute with their own original research to expand the boundaries of the scientific field, which deserves publication at the national or international level;
- 4) critically analyze, evaluate and synthesize new and complex ideas;
- 5) communicate their knowledge and achievements to colleagues, the scientific community and the general public;
- 6) to promote, in an academic and professional context, the technological, social or cultural development of a knowledge-based society.

6 ECTS Diploma Supplement

The application was developed according to the standards of the European Commission, Council of Europe and UNESCO / CEPES. This document is for academic recognition only and is not an official proof of education. Not valid without a university degree. The purpose of completing the European Supplement is to provide sufficient information about the holder of the diploma, the qualification obtained, the level of this qualification, the content of the study program, the results, the functional purpose of the qualification, as well as information about the national education system. The application model that will be used to translate grades uses the European Credit Transfer or Transfer System (ECTS).

The European Diploma Supplement provides an opportunity to continue education at foreign universities, as well as to confirm national higher education for foreign employers. When going abroad for professional recognition, additional legalization of the educational diploma is required. The European Diploma Supplement is completed in English upon individual request and is issued free of charge.

Additive manufacturing

CODE – MCH281

CREDIT – 3 (1/1/1)

PRE-REQUISIT – no

PURPOSE AND OBJECTIVES OF THE COURSE

The purpose of studying the discipline is to acquire knowledge about additive technologies and familiarize with the structure of modern additive manufacturing and the content of its technological processes.

The main task of studying the discipline is mastering the methods of creating products from modern materials on additive equipment, the structure and methods of additive manufacturing.

SHORT DESCRIPTION OF THE COURSE

The course provides information on the types of additive technologies for the manufacture of workpieces and parts of mechanisms and structures from them, as well as on additive equipment for the main types of their processing. The focus is on classifications, performance, brands, applications.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

As a result of studying the course, the student should know: the basics of technologies for the additive production of engineering materials; The student should have an idea of the trends and prospects for the development of modern additive systems and their technological purpose. The student should be able to choose ways to solve design problems of additive manufacturing; apply modern 3D printers to solve problems of design and technological design The student should be able to: apply additive technologies in laboratory conditions and in practice, taking into account the analysis of their properties; measure the main parameters of materials and evaluate their mechanical properties; choose the best methods and methods of additive manufacturing.

Digital Manufacturing Risk Management

CODE – ISO

CREDIT – 3 (2/0/1)

PRE-REQUISIT – quality management systems, fundamentals of engineering production design, production organization.

PURPOSE AND OBJECTIVES OF THE COURSE

The purpose of teaching the discipline "Risk Management in Production" is the acquisition by students of theoretical and practical knowledge in risk management in production, mastering the methodology of project management, competent planning of short-term work, forecasting such activities, analyzing their work, identifying weaknesses in activities.

SHORT DESCRIPTION OF THE COURSE

During this course, issues are considered that will allow future specialists - masters to have information about the basics of risk management, project management, basic requirements for the plant and the structure of a modern machine-building enterprise (classification, workshops and services): design of a technological process; identification of weak points in the process, basic principles of equipment placement; basic provisions for the organization of the workplace and the requirements for them.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

The course provides undergraduates with information about the history of the development of the project management method and its concept, the basics of project and risk management; develop a project concept and assess the effectiveness and risk potential; know the methods of assessing the effectiveness of the project; be able to plan projects, identify risk opportunities and its consequences; structure projects and develop design estimates; manage project time, calculate risk opportunities; perform complex modeling of the project schedule and risks; assess the cost of the project; manage the cost of the project and the emergence of risks; have an understanding of the organizational structures of project management, project team management, project completion and analyze projects.

Optimal machine design

CODE – ISO

CREDIT – 2 (1/0/1)

PRE-REQUISIT – theory of mechanisms and machines, machine parts, resistance of materials.

PURPOSE AND OBJECTIVES OF THE COURSE

The aim of teaching the discipline "Optimal machine design" is the design of machines and mechanisms, the most important part of modern mechanical engineering. These are professional skills that take a long time to learn, creativity, courage of thinking, knowledge of working methods, etc. The course introduces the basic skills of design work - the choice of a machine diagram, its layout, design implementation, preparation of a technical task, carrying out kinematic calculation, power calculations, the choice of design elements, drive.

SHORT DESCRIPTION OF THE COURSE

In the process of studying this course, knowledge and skills are given to carry out design work to create working projects for which factories will be able to produce new original machines and mechanisms. At present, all attention for the training of designers in mechanical engineering is given to familiarization with the available computer programs for drawing and calculating machines. But the computer itself will not design a machine or mechanism. A machine is not designed by a computer and in the designer's head, and then he enters it into the computer's memory using computer graphics programs. This course teaches you how to create a new machine in a person's head. This is the statement of the problem, the choice of the necessary scheme, drive, interaction of machine elements with each other, structural elements - bearings, shafts, gear wheels, couplings, etc. The course examines the technological process of creating a new machine design, from a sketch design to working drawings of parts and an assembly drawing, etc.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

The course provides an opportunity for masters to learn the methodology of designing machines and mechanisms, all stages of the design process, their content and significance are studied.

Skills and skills acquired during the course:

- the ability to use the knowledge gained from previous courses for real design work;
- practical skills in performing specific design work on the terms of reference for the design of equipment;
- the ability to perform a professional analysis of a working project;
- apply advanced design methods to obtain high quality parameters of the machine.

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Digital Manufacturing Design

CODE – ISO

CREDIT – 3 (2/0/1)

PRE-REQUISIT – quality management systems, fundamentals of engineering production design.

PURPOSE AND OBJECTIVES OF THE COURSE

The aim of teaching the discipline "Design of digital production" is "modernization and automation of existing and design of new effective machine-building industries for various purposes, means and systems for their equipment, production and technological processes using automated systems for technological preparation of production.

SHORT DESCRIPTION OF THE COURSE

Preparation of assignments for the modernization and automation of existing mechanical engineering, production and technological processes and industries, tools and systems necessary for the implementation of automation and modernization; participation in the development of projects for machine-building industries, taking into account the technological, design, operational, aesthetic, economic and managerial parameters that ensure their effectiveness; development of projects of engineering industries;

development and implementation of optimal technologies for the manufacture of mechanical engineering products; modernization and automation of existing and design of new efficient machine-building industries using automated systems for technological preparation of production; organization of work on the design of new engineering industries, their elements, modernization and automation of existing ones; participation in the development of plans and programs for organizing innovative activities at the enterprise; mathematical modeling of processes, tools and systems of engineering industries using modern technologies for scientific research.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

The course enables undergraduates to participate in the development of projects for mechanical engineering industries, taking into account technological, design, operational, aesthetic, economic and managerial parameters, to develop generalized options for solving design problems, to analyze and choose optimal solutions, predict their consequences, plan the implementation of projects; the ability to develop and implement effective technologies for machine-building products, participate in the modernization and automation of existing and design of new machine-building industries for various purposes, means and systems for their equipment, production and technological processes using AMTPP;

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Design and operation of machines and equipment for gas and flame atomization

CODE – MCH294

CREDIT – 3 (2/0/1)

PRE-REQUISIT – no

PURPOSE AND OBJECTIVES OF THE COURSE

The purpose of teaching the discipline is to study the methodology of modern methods of designing atomization systems. Undergraduates must have knowledge of the basic techniques for constructing atomization, distinguish between modern architecture, have an idea of atomization, its features and scope.

SHORT DESCRIPTION OF THE COURSE

The course "Design and Operation of Machines and Equipment for Gas and Flame Atomization" is intended to study the methods of designing atomizers, to develop skills in the design of gas atomization systems. The main sections are: the architecture of modern atomizers, device programming, studying the possibilities of creating software models, developing and debugging atomizers.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

As a result of studying the discipline, a master student must:

know:

- basic techniques for constructing gas atomization systems, to distinguish the architecture of modern atomizers, to have an idea of the element base of atomizers, its features and scope;

be able to:

- choose the architecture of a programmable system, evaluate the capabilities of the developed atomizers in accordance with the characteristics of the input and output data and processing algorithms;

own:

- practical skills in the use of gas atomizers in the design of additive systems.

Operation of plants for additive manufacturing

CODE – MCH202

CREDIT – 3 (2/0/1)

PRE-REQUISIT – no

PURPOSE AND OBJECTIVES OF THE COURSE

The purpose of the discipline is to study methods for assessing the reliability of additive systems at the design stage, study methods for assessing the reliability of additive systems in operation, the use of probability theory for predicting and preventing equipment failures, studying methods for diagnosing existing equipment.

SHORT DESCRIPTION OF THE COURSE

The discipline "Operation of plants for additive manufacturing" includes the following main areas. Modern scientific concepts in the development of safety assessment of additive systems. The theory of the reliability of devices, machines and structures. Reliability indicators, mathematical models of reliability and survivability. Mathematical expectations of the number of failures and the application of the theory of reliability and survivability to the design conditions of additive machines and structures. Vitality theory. Damage accumulation models. Fatigue Fracture Mechanics. Forecasting at the design stage. Monitoring the destruction of additive machines and mechanisms. Maintenance planning. In accordance with the above, the teaching of the discipline "Operation of installations for additive manufacturing" aims to equip future specialists with knowledge of the basic provisions of the theory of reliability and survivability of additive systems.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

After studying this discipline, the master must:

know and be able to:

- to apply in practice the main provisions of the theory of reliability, to evaluate the reliability of additive systems, the theory of reliability in the additive industry, which is based on mathematics and technical disciplines,

correctly represent:

- man-made risk inherent in the proposed project, submitted for technical expertise and be competent in the implementation of measures designed to minimize damage in the event of industrial accidents, evaluate the methods of 3D printers for their prediction and prevention,

skills:

- assessing the reliability and technogenic risk of technical systems under construction and modernization.

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3D scanning and digitization

CODE – MCH297

CREDIT – 3 (2/0/1)

PRE-REQUISIT – no

PURPOSE AND OBJECTIVES OF THE COURSE

- based on the theoretical foundations of 3D scanning methods, develop and select the most modern and promising types of technological processes.
- The objectives of the course include:
- Acquaintance with modern and promising types of technological processes ZD-scanning, which would be distinguished by the greatest accuracy, productivity
- To teach to use 3D scanning in the development of modern and advanced types of technological processes.
- Application of traditional methods of 3D scanning, but with increased accuracy and productivity.
- Use of high energy methods.
- Train to use algorithmic methods for 3D scanning

SHORT DESCRIPTION OF THE COURSE

The course contains a training program aimed at leveling the basic knowledge of students in the field of modern and promising types of technological processes 3D scanning. The course is structured in such a way as to teach undergraduates not only the basic concepts of modern 3D scanning technologies, but also teach how to use these tools to solve problems of an applied and scientific nature. To teach how to optimize processes, apply adequate models and methods for solving practical problems in the choice of one or another 3D scanning technology using modern methods and tools of information technology, automate routine processes, be productive and efficient.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Undergraduates will know:

- the most modern and promising types of 3D scanning

Master's students will be able to:

- develop the most modern and promising types of 3D scanning
- reasonably choose from a set of typical technological processes 3D-scanning based on the specified requirements for the quality of parts

Content

Writing and defending a doctoral dissertation

CODE –

CREDIT –12

The purpose of the doctoral dissertation is to assess the scientific-theoretical and research-analytical level of the doctoral student, the formed professional and managerial competencies, the readiness to independently perform professional tasks and the compliance of its preparation with the requirements of the professional standard and the educational program of doctoral studies.

SHORT DESCRIPTION OF THE COURSE

Doctoral dissertation is a scientific work of a doctoral student, which is an independent study, in which theoretical provisions are developed, the totality of which can be qualified as a new scientific achievement, or a scientific problem is solved, or scientifically grounded technical, economic or technological solutions are stated, the implementation of which makes a significant contribution to development the country's economy.

The doctoral dissertation is the result of the research / experimental research work of a doctoral student, carried out during the entire period of study of a doctoral student. The defense of a doctoral dissertation is the final stage of the master's preparation. A master's thesis must meet the following requirements:

- The topic of the thesis should be related to priority areas of development of science and / or government programs or programs of fundamental or applied research.
- The content of the thesis, the goals and objectives, the scientific results obtained must strictly correspond to the topic of the thesis.
- The dissertation is carried out in compliance with the principles of independence, internal unity, scientific novelty, reliability and practical value.

1 Scope and content of the program

2 Requirements for applicants

3 Requirements for completing studies and obtaining a diploma

3.1 Requirements for key competencies of doctoral graduates

3.2 Requirements for R&D of a student under the Ph.D. program

3.3 Requirements for organizing practices

4 Working curriculum of the educational program

5 Descriptors of the level and amount of knowledge, skills, abilities and competencies

6 ECTS Diploma Supplement