NAO "Kazakh National Research Technical University named after K.Satpayev"

Institute of Energy and Mechanical Engineering
Department of Engineering Mechanics and Modeling

EDUCATIONAL PROGRAM

6B07106 - "Mechanical Engineering"

Code and classification of the field of education: 6B07 - Engineering, manufacturing and construction industries
Code and classification of training areas: 6B071 - Engineering and Engineering
Group of educational programs: B064 - «Mechanics and metal working»
The level of the NRK: 6B
ORC Level: 6
Duration of study: 4 years
Volume of credits: 242

г. Almaty, 2022

Educational program 6B07106 - Mechanical Engineering
approved at the meeting of the Academic Council of Kazntu named after K.I.Satpayev.

Protocol no. ___ from "___" _____2021 g.
Reviewed and recommended for approval at a meeting of the Educational and Methodological Council of Kazntu named after K.I.Satpayev.

Protocol no. ___ from "___" _____ 2021 g.
Educational program 6B07106 - Mechanical Engineering
developed by the academic committee for the group of educational programs:
B064 - Mechanics and metal working

Full name	**Academic degree/academic title**	**Post**	**Place of work**	**Signature**
Chairman of the Academic Committee:				
Kaltayev A.	D.F.-M.N./Prof.	Head of the Department	Satbayev University	
Teaching staff:				
Dzhanaev S.K.	Candidate of Technical Sciences/assoc. prof.	Chairman of the UMS of the Department	Satbayev University	
Students:				
Bodau B.B.	3 kurs	Students	Satbayev University	
Employers:				
Tuleshov A.K.	Doctor of Technical Sciences/prof.	General manager	Institute of Mechanics and Machine Science LLP	

List of abbreviations and designations

OP - educational program,
PO – learning outcomes,
MJG – Fluid and Gas Mechanics

1. Description of the educational program

The educational program **"Engineering Mechanics"** is aimed at preparing bachelors to solve a wide range of engineering problems of mechanics based on fundamental knowledge in mathematics, mechanics, physics, chemistry and engineering principles using modern analytical, experimental and numerical methods and methods of mathematical and computer modeling. When preparing students, a broad systematic approach is followed, when engineering decisions are made by graduates with a full understanding of the possibilities and limitations of research methods and advanced technologies used.

Thus, the mission of the Engineering Mechanics educational program is to provide the market with highly qualified specialists with fundamental knowledge in the fields of natural sciences, engineering mechanics and computer modeling to work in the field of high-tech engineering.

The curriculum of the Engineering Mechanics educational program is developed in accordance with the curricula of the Mechanical Engineering educational program of the best research and engineering universities in the world, such as Massachusetts Institute of Technology – MIT, Stanford University, University of Cambridge, Georgia Institute of Technology, Technical University of Munich, Pennsylvania State University, Tokyo University, Nanyang Technological University (Singapore), and others, taking into account the current trends in technology development.

In the course of training, special attention is paid to mathematics, the laws of physics and mechanics underlying modern engineering design, numerical and computer modeling methods and information technologies. The basic education received in these areas of knowledge will allow future specialists to easily integrate into the workflow of almost any industry, it is easy enough to master a wide range of new technologies.

In the first two courses (in the first 4 semesters), students have the opportunity to receive fundamental basic education in mathematics (differential and integral calculus, vector analysis, algebra and geometry, differential equations, equations of mathematical physics), physics (molecular physics, thermodynamics, electricity and magnetism, optics and atomic physics), mechanics (statics, strength of materials, dynamics), chemistry, information and digital technologies (information and communication technologies, numerical methods and programming), Kazakh and English languages. These basic sciences are the basis of any technology and will allow students who have mastered them to easily master new technologies and retrain for other modern specialties.

At senior courses, students study in-depth special courses in mechanics and engineering (engineering thermodynamics, engineering materials, fluid mechanics, solid mechanics, theory and design of mechanisms and machines, design of machine elements, fundamentals of heat and mass transfer, numerical methods for solving engineering problems, fundamentals of robotics, design of mechanical systems and elective courses) and gain skills numerical and computer modeling, design of machine elements and structures, design of mechanisms and mechanical systems, numerical modeling and research of various mechanical processes and phenomena,

development and creation of robots and manipulators. Primary attention is paid to the acquisition by graduates of skills in developing computer models of various engineering tasks and hydraulic systems, complex mechanical, thermal or mass transfer processes in various industries using modern computing and information technologies.
Students undergo practical training in research institutes, state and departmental structures, in such companies as Kazatomprom JSC, Kazmunaygas JSC, at the Institute of Mechanics and Machine Science, at the Institute of Mathematics and Mathematical Modeling, etc. According to the academic mobility program, the best students have the opportunity to study at leading foreign universities according to the appropriate educational program.
The educational program will make it possible to implement the principles of the Bologna process. Based on the students' choice and independent planning of the sequence of studying disciplines, they independently form an individual study plan for each semester according to the curriculum and the catalog of elective disciplines.
At all levels of training, teaching is conducted by highly qualified teaching staff, among them there are graduates of universities in the USA, Europe, Russia and other countries
Graduates can choose different career paths. Some may go into industry directly as practicing engineers, while others may continue to study for a master's degree in mechanical engineering or applied sciences. Many make a career in business or in public activities. The best graduates have studied or are studying in master's or doctoral studies at KazNU, WELL, Purdue University, Georgia Institute of Technology, National University of Singapore, University of Pittsburgh, University of Lorraine and many other universities.
The Bachelor's degree program "Engineering Mechanics" is the first level of qualification of a three-level system of higher education, it lays the foundation for subsequent master's programs, and then doctoral programs.

2. The purpose and objectives of the educational program

The purpose of the educational program is to train highly qualified personnel: having fundamental knowledge in mathematics, mechanics, physics and chemistry, modeling methods and information technologies; able to apply knowledge and skills for the development and design of new mechanisms and mechanical devices, autonomous mechanisms and robots, mechanical and thermal systems, heat and mass transfer processes and installations, converters and accumulators of renewable energy sources; able to use knowledge to manage modern technological processes in mechanical engineering and power engineering and to introduce the most effective technologies into production.

Objectives of the educational program:
1) to provide knowledge and understanding of the principles of mechanics, physics and mathematics underlying the various specializations of engineering mechanics;

2) instill the ability to find the necessary literature, use databases and other sources of information;
3) teach to choose and use suitable equipment, tools and methods for experimental research of mechanics problems;
4) teach the methodology of modeling and designing engineering systems and the ability to apply them to solve practical problems;
5) teach to develop and design new mechanisms and mechanical devices, autonomous mechanisms and robots, mechanical systems;
6) teach to investigate and design heat and mass transfer processes, and installations, converters and accumulators of renewable energy sources, etc.
7) teach to apply the acquired knowledge for the analysis of engineering systems and processes related to various areas of engineering mechanics, including using computer modeling methods;
8) teach to apply the acquired knowledge to the management of production and technological processes in mechanical engineering and energy;
9) teach to analyze the available information from a critical point of view;
10) instill the ability to work effectively both individually and as a team member;
11) show awareness in the field of project management and business, knowledge and understanding of the impact of risks and changing conditions;
12) be aware of the need and have the ability to independently study and improve their skills during their lifetime;
13) understand health, safety, legal aspects and responsibility for engineering activities, understand the impact of engineering solutions on the social context and the environment:
14) follow the code of professional ethics and standards of engineering practice.

Areas of professional activity of the graduate

profession	Labor function A scientific	Professional task A1: develop modern mechanical systems, mechanisms and mechanical devices, and work,	Knowledge Mathematics I-III, ODE, Strength of materials, Engineering Materials, Solid Mechanics, Theory and Design of mechanisms and machines, Numerical Methods and Programming, Design of Machine elements, Introduction to Electronic Measuring Systems, Design of Mechanical Systems, Introduction to Robotics.
			Skills Ability to work with high-tech laboratory and research equipment. The ability to develop new mechanisms and devices, including robots.
			Standards of behavior: Self-learning and systems thinking; ICT competencies; creativity; cooperation with

			team members; ability to make decisions quickly, respond to changes in working conditions.
			Equipment and tools Computer systems, 3D printers, special materials and structures, equipment for the study of mechanical properties of materials, electronic measuring systems, electrical equipment.
			Future trends The ability to develop effective mechanical structures and autonomous mechanical systems, and robots.
		Professional task A2: develop efficient hydraulic and thermal systems, energy and mass transfer processes.	Knowledge Mathematics I-III, Linear Algebra and Analytical Geometry, Physics I-II, General Chemistry, Statics, Dynamics, ODE, Partial Differential Equations, Engineering Thermodynamics, Fluid Mechanics, Numerical Methods and Programming, Fundamentals of Heat Transfer, Numerical Methods for Solving Engineering Problems.
			Skills Ability to program in algorithmic languages, proficiency in modeling and research of complex physical and mechanical processes. Ability to work with high-tech laboratory and research equipment, high-performance computing systems. Ability to independently develop adequate physical and mathematical models of mechanical processes and phenomena. Ability to use mathematical and computer models of mechanical processes for independent research of a wide range of engineering problems of mechanics and design of various mechanical and energy systems.
			Standards of behavior: Self-learning and systems thinking; ICT competencies; creativity; cooperation with team members; ability to make decisions quickly, respond to changes in working conditions.
			Equipment and tools High-performance computing systems, specialized software and experimental installations for fluid mechanics, mass transfer devices and thermal systems, energy, research equipment.
			Future trends The ability to use machine learning methods to study stochastic problems of mechanics. The ability to use quantum computing systems to solve resource-intensive problems of fluid mechanics.

	Labor function B design and engineering	Professional task B1: design and create mechanisms and mechanical devices, mechanical systems and robots.	Knowledge Mathematics I-III, ODE, Strength of Materials, Engineering Materials, Solid Mechanics, Numerical Methods and Programming, Theory and Design of mechanisms and machines, Design of Machine elements, Introduction to Electronic Measuring Systems, Design of Mechanical Systems, Introduction to Robotics.
			Skills Ability to work with high-tech laboratory and research equipment. The ability to design and create new mechanisms and devices, including autonomous mechanisms and robots.
			Standards of behavior self-learning and system thinking; ICT competencies; creativity; cooperation with team members; ability to make decisions quickly, respond to changes in working conditions.
			Equipment and tools 3D printers, computer systems, special materials and structures, equipment for the study of mechanical properties of materials, electronic measuring systems, electrical equipment.
			Future trends The ability to design and create effective mechanical structures and autonomous mechanical systems, and robots.
		Professional task B2: to design and create heat and mass transfer installations, converters and accumulators of renewable energy.	Knowledge Mathematics I-III, Linear Algebra and Analytical Geometry, Physics I-II, General Chemistry, Statics, Dynamics, ODE, Partial Differential Equations, Engineering Thermodynamics, Fluid Mechanics, Numerical Methods and Programming, Fundamentals of Heat Transfer, Numerical Methods for Solving Engineering Problems.
			Skills Ability to conduct experimental and numerical studies of fluid flow in pipes, channels of hydraulic systems, heat and mass transfer processes in thermal devices and reactors based on knowledge of differential equations and numerical methods for solving fluid mechanics problems. Ability to design and create physical and mathematical models of mechanical and thermal phenomena and processes in engines, heat exchange plants and chemical reactors.
			Standards of conduct Self-learning and system thinking; ICT competencies; creativity; cooperation with team

			members; ability to make decisions quickly, respond to changing working conditions.
			Equipment and tools High-performance computing systems and experimental installations for MFG, specialized software and experimental installations for fluid mechanics, mass transfer devices and thermal systems, energy, research equipment.
			Future trends Ability to design and create highly efficient heat and mass transfer installations and thermal energy accumulators
	Labor function C production and technological, organizational and managerial	Professional Task C1: manage production and technological processes in mechanical engineering and energy	Knowledge Mathematics I-III, ODE, Strength of Materials, Engineering Materials, General Chemistry, Fluid Mechanics, Solid Mechanics, Theory and Design of Mechanisms and Machines, Design of Machine Elements, Introduction to Electronic Measuring Systems, Engineering Thermodynamics, Design of Mechanical Systems, Fundamentals of Heat Transfer.
			Skills Ability to model and program technological tasks, skills in the study of complex physical and mechanical processes. Knowledge of methodology: system analysis; design and decision-making in complex and professional situations; methods of communication and coordination of points of view; design and presentation of analytical and project documentation.
			Standards of conduct Self-learning and system thinking, technological literacy, entrepreneurship, customer orientation, the ability to make decisions quickly, respond to changes in working conditions, the ability to allocate resources and manage your time.
			Equipment and tools Equipment for mechanical engineering and energy.
			Future trends The ability to manage high-tech processes in mechanical engineering and energy.

3. Requirements for the evaluation of learning outcomes of the educational program

List of competencies
General competencies

Knowledge of Kazakh, Russian and English languages for: free oral and written communication with a native speaker of a particular language on a professional topic and in a real-life situation; search for scientific and technical information in these languages; work with scientific and technical literature on engineering mechanics in these languages.
• Mastery of critical systems thinking, transdisciplinarity and cross-functionality.
• Possession of ICT competencies, the ability to develop software.
• Mastery of skills: self-study; deepening of one's knowledge; being open to new information; system thinking and one's own judgment.
• The ability to be tolerant of another nationality, race, religion, culture; the ability to conduct an intercultural dialogue.
• Possession of communication skills, the ability to cooperate and work in a team.
• Ability to work in a mode of high uncertainty and rapid change of task conditions; to work with consumer requests.
• Possession of a broad socio-social, political and professional outlook; ability to use data from various sources and specialized literature, analyze and critically evaluate historical facts and events.
• Knowledge of the basics of entrepreneurship and business economics, readiness for social mobility.

Professional competencies

• Possession of fundamental knowledge in mathematics, mechanics, physics and scientific principles and the ability to use them in solving engineering problems.
• The ability to independently develop adequate physical and mathematical models of mechanical processes and phenomena.
• Ability to use mathematical and computer models of mechanical processes for independent research of a wide range of engineering problems of mechanics and design of various mechanical and energy systems.
• The ability to develop new mechanisms and devices, including autonomous mechanisms and robots.
• Ability to work with high-tech laboratory and research equipment.
• Knowledge of algorithmic languages and programming technology, computer modeling skills and research of complex physical and mechanical processes.
• Proficiency in working as a designer in mechanical engineering, energy, transport, chemical production.
• Knowledge of methodology: system analysis; design and decision-making in complex and professional situations; methods of communication and coordination of points of view; design and presentation of analytical and project documentation.

Learning outcomes

RO 1 – to search and study scientific and technical information on engineering mechanics in Kazakh (Russian) and English;

RO 2 – express your opinion in writing and orally on the topic of engineering mechanics in Kazakh (Russian) and English;
RO 3 – critically analyze historical sources, possess the skills of independent analysis of historical facts, identify alternative ways of posing and solving ideological issues in the history of human development;
RO 4 – to program in a modern algorithmic programming language; to possess modern computer design tools;
RO 5 – differentiate and integrate functions of one and many variables; apply integral theorems and elements of tensor analysis in problems of fluid and solid mechanics;
RO 6 – to understand the fundamental physical foundations and laws of the universe in order to apply them with knowledge in the study and solution of engineering problems;
RO 7 – perform calculations on the dynamics of bodies, the theory of mechanisms and machines and machine parts based on knowledge of the theories of differential and integral calculus, vector analysis;
RO 8 – to conduct research and calculations on deformations of bodies, heat and mass transfer processes in thermal devices and reactors based on knowledge of mathematical analysis, differential equations, numerical methods of solid mechanics and fluid mechanics;
RO 9 – have the skills to work with modern application software to determine the behavior of solids, fluid flow in pipes, channels and devices and use them to solve engineering problems;
RO 10 – to develop and build physical and mathematical models of mechanical systems and thermal phenomena and processes in engines, heat exchange plants and chemical reactors;
RO 11 – develop and design various mechanisms and machine parts, mechanical systems and devices, autonomous mechanisms and robots;
RO 12 – to choose optimal numerical methods and develop, create software that allows computer calculations, modeling and research of mechanical, hydraulic and heat and mass transfer problems in pipes, channels and devices;
RO 13 – conduct independent research using analytical, experimental or numerical methods on the development and creation of new mechanical devices, robots, mass transfer or thermal devices.

Learning strategy

The strategy of the Engineering Mechanics educational program is focused on training highly qualified specialists with fundamental knowledge in the fields of natural science, engineering mechanics and computer modeling to work in the field of high-tech engineering, considering current trends in the development of engineering mechanics.
In the course of training, special attention is paid to the development by students of methods of mathematical, numerical and computer modeling of engineering

problems, the use of software packages for solving and researching various problems of engineering mechanics. To achieve this goal, the structure of classes in almost all specialized disciplines includes both laboratory and practical classes, i.e. the theoretical knowledge of students is firmly anchored by the skills of their practical application.

In the course of graduates' graduation work on the educational program, the main attention is paid to instilling in graduates the skills independently or in a team to develop physical or virtual models of sufficiently complex mechanical and physico-chemical processes and phenomena, to create computer codes or apply modern software products to solve them and on their basis to develop energy and/or heat and mass transfer devices, mechanical systems and machines, robots and manipulators.

Possession of fundamental knowledge in the fields of natural sciences, engineering mechanics and computer modeling skills will allow graduates to integrate relatively easily into the workflow of almost any industry, it is easy enough to master a wide range of new technologies.