Emerging competencies

№	Name of disciplines	Brief description of the discipline	Number of credits	Emerging competencies
		Cycle of general education disciplines University component		
1	English - LNG108	**Purpose:** aimed at developing students' reading and listening skills and writing and speech skills, mastering pronunciation features and elementary vocabulary. **Summary** Fundamentals of English grammar, to lay a certain foundation for the student, which will allow him to improve his skills at the next stage of learning English by analyzing basic knowledge, using and memorizing the main grammatical rules.	10	Mastering the peculiarities of pronunciation and elementary vocabulary. Ability to communicate verbally on basic topics in English. The ability to communicate in writing on basic and professional topics in English using a dictionary. Ability to work with sources and scientific and technical information on engineering mechanics in English
2	Kazakh (Russian) language LNG104	**Purpose:** to teach you to understand texts on personal and professional topics containing the most frequent words and expressions; to be able to conduct a conversation on everyday topics; to describe your experiences; to express your opinion. **Summary** to give a lexical and grammatical minimum, to acquaint with typical communicative situations, to evaluate them correctly and to choose the appropriate model (strategy) of speech behavior;	10	Mastering the skills of reading, writing and understanding a sounding word on the basis of simultaneous mastery of the basics of grammar (phonetics, morphology and syntax) and word usage. Be able to conduct a conversation on everyday topics; describe your experience; express your opinion; present and evaluate the content of the book you read, the movie you saw. The ability to compose simple texts on well-known topics, including those related to professional activity.

		to teach the ability to use the language being studied, during the implementation of various types of speech activity.		
3	Information and Communication technology- CSE677	**Purpose:** training in the use of modern information technologies in the field of professional activity. **Summary** The basic concepts of the architecture of computer systems, information and communication technologies and subject terminology. Software interfaces of operating systems. Working with data in a different view. Basic principles of information security. Data formats and multimedia content. Modern social, cloud and email platforms and ways to work with them. Algorithmization and programming methods for solving engineering problems.	5	Skill: working with interfaces of modern operating systems; work with modern application software for working with data of various nature and purpose; apply modern social, cloud, and email platforms to organize business processes; programming in an algorithmic programming language.
4	Modern history of Kazakhstan HUM100	**Purpose:** to familiarize students with the main achievements of the national historical science on the problems of the history of modern Kazakhstan, a comprehensive and systematic study of the main stages of the formation and development of Kazakh society. **Summary** The period from the beginning of the twentieth century to the present day. The national liberation movement of the Kazakh intelligentsia at the beginning of the XX century, the period of the creation of the Kazakh SSR, as well as the process of formation of society.	5	Skill: work with all kinds of historical sources; writing essays and scientific articles on the history of the Fatherland; to operate with historical concepts; to conduct a discussion. Possession of skills of independent analysis of historical facts, events and phenomena; public speech.

5	Philosophy HUM132	**Purpose:** formation of cognitive, operational, communicative, self-educational competencies for the development of adequate ideological guidelines in the modern world. **Summary** "Philosophy" is the basis for the formation of a holistic worldview. The main paradigms of philosophy and classical and postclassical traditions of philosophy. The connection of philosophy with the development of stable life orientations, the acquisition of the meaning of being as a special form of spiritual production.	5	• Ability • to analyze the history of the development of philosophical thought; • to identify alternative ways of posing and solving ideological issues in the history of human development; to identify the main theoretical approaches in the relationship of a person with society.
6	Module of socio-political knowledge (sociology, political science)- HUM120	**Purpose:** formation of systematic knowledge about the political sphere of public life, consistent and comprehensive study of the origins and evolution of the political thought of the Kazakh people at the stage of its historical development, political heritage and its most prominent representatives.	3	• Ability • to analyze the history of the development of philosophical thought; • to identify alternative ways of posing and solving ideological issues in the history of human development; to identify the main theoretical approaches in the relationship of a person with society.
7	Module of socio-political knowledge (cultural studies, psychology) – HUM134	**Purpose**: to contribute to the formation of a holistic view of a person's personal characteristics as a factor of success in mastering and implementing their educational and professional activities. **Summary** Mental processes, properties and conditions of a person in various fields of human activity, interpersonal and social interactions, ways and forms of	5	• Ability • to analyze the history of the development of philosophical thought; • to identify alternative ways of posing and solving ideological issues in the history of human development; to identify the main theoretical approaches in the relationship of a person with society.

		their organization and changes when exposed.		
		Cycle of general education disciplines Elective component		
8	Fundamentals of anti-corruption culture – HUM133	**Purpose:** The discipline "Fundamentals of anti-corruption culture" is an important component and belongs to the number of social and humanitarian disciplines. **Summary** This discipline reveals the general patterns of the emergence, development and functioning of the anti-corruption culture, and organically related other social phenomena and processes.	5	• Ability • to analyze the history of the development of philosophical thought; • to identify alternative ways of posing and solving ideological issues in the history of human development; to identify the main theoretical approaches in the relationship of a person with society.
9	Fundamentals of Entrepreneurship and Leadership – MNG488	**Purpose:** Students will study the theory and practice of entrepreneurship as a system of economic, organizational and legal relations of business structures. The discipline is aimed at revealing the content of entrepreneurial activity, career stages, qualities, competencies and responsibilities of a modern entrepreneur, as well as theoretical and practical business planning and economic expertise of business ideas.They will develop their leadership and teamwork skills.	5	The discipline is aimed at revealing the content of entrepreneurial activity, career stages, qualities, competencies and responsibilities of a modern entrepreneur, as well as theoretical and practical business planning and economic expertise of business ideas. They will develop their leadership and teamwork skills.
10	Ecology and life safety – CHE656	**Purpose:** formation of concepts and ideas about the inseparable unity of effective professional activity with the requirements of human safety and security and environmental protection. The issues of ecology, life safety in working conditions are considered.	5	Ability During the problematic seminars, the sources of atmospheric air pollution, surface, groundwater, soil and ways to solve environmental problems are considered; life safety in the technosphere; natural and man-made emergencies.

		Summary During the problematic seminars, the sources of atmospheric air pollution, surface, groundwater, soil and ways to solve environmental problems are considered; life safety in the technosphere; natural and man-made emergencies.		
		Cycle of basic disciplines University component		
11	Mathematical Analysis I - MAT 169	**The purpose** of the discipline is to acquire theoretical and practical knowledge on the methods of introduction to analysis and differential calculus of functions of one variable **Summary** The discipline deals with differential and integral calculus; functions, continuity and differentiability of functions, the mean theorem, Taylor formulas; the study of functions. Investigation of monotonicity functions using the first derivative, the extremum point; investigation of convexity functions using the second derivative, the inflection point. Asymptotic behavior of functions.	5	The ability to find: the limits of continuous functions, the derivative of elementary functions of one variable, higher-order derivatives of a function of one variable; to investigate the functions of one variable using a derivative; to use for solving problems of mechanics and engineering.
12	Physics I: Molecular Physics. Thermodynamics - PHY469	**Purpose:** formation of ideas about the fundamental laws of mechanics and thermodynamics, about the molecular structure of bodies. **Summary** Newton's laws of mechanics, applications in engineering. Molecular structures of bodies and their physical	5	Possession of a system of knowledge about the fundamental physical foundations and laws of mechanics and its theories, molecular physics and thermodynamics. The ability to apply this knowledge in solving problems of engineering mechanics.

		properties. Concepts and laws of thermodynamics.			
13	Linear Algebra and Analytic Geometry - MAT189	**Purpose:** to provide basic knowledge on methods of solving algebraic equations and systems of linear equations, to introduce methods of analytical geometry on the plane and in space. **Summary** Determinants. Algebraic equations: general theorems. Decomposition and division of polynomials. Systems of equations. Matrices, algebra of matrices. Analytical geometry on a plane. Analytical geometry in space.	5		Knowledge of methods of solving: algebraic equations of 1-4 degrees, systems of linear equations; operate with matrices. The ability to use the methods of analytical geometry to describe and study the problems of engineering mechanics.
14	Mathematical Analysis II- MAT170	**Purpose:** to provide basic knowledge on integral calculus of a function of one variable. **Summary** Fundamentals of integral calculus of a function of one variable: definite integrals, indefinite integrals, the main theorem of integral calculus, properties of integrals, integration methods. Application of integral calculus in mechanics and engineering.	5		The ability to calculate integrals from elementary functions of one variable; to find indefinite and definite integrals from elementary functions of one variable; to find the length of an arc, the area of a curved trapezoid; to use in solving problems of mechanics and engineering.
15	Physics II: Electricity and Magnetism. Nuclear physics - PHY471	**Purpose:** to provide basic knowledge on the laws of m electromagnetism and their conscious application in science and technology. **Summary** Laws of electricity and magnetism, static electricity, electric currents, magnetic phenomena.	5		Understanding of the physical essence of the laws of electromagnetism and the ability to apply them in engineering and engineering. The ability to use methods of physical research to solve problems of mechanics.

16	Mathematical analysis III - MAT171	**Purpose:** to provide basic knowledge on differential and integral calculus of functions of many variables. **Summary** Differential and integral calculus of a function of many variables. Curvilinear, double and multiple integrals; surface and volume integrals; mean value theorems; Fourier series and integrals. Applications of differential and integral calculus of functions of many variables in mechanics and engineering.	5	Ability to calculate: differentials of a function of many variables; integral of a function of many variables; curvilinear, double and multiple integrals; surface areas and volumes of figures and masses of bodies. It can be used to solve problems of mechanics and engineering.
17	Ordinary differential equations - MAT110	**Purpose**: formation of basic knowledge on the sections of the theory of ordinary differential equations (ODES), formulation of problems and methods of solutions**.** **Summary** ODE of the 1st order. The Cauchy problem. An ODE of higher orders. ODE systems. Linear odes with variable coefficients. Numerical integration of ODES and ODE systems. Using Matlab for numerical solution of ordinary differential equations.	5	Knowledge of the basics and methods of solving ODES; the ability to build mathematical models of mechanics and engineering problems described by the ODE; the ability to solve problems described by the ODE using both analytical and numerical methods using Matlab.
18	Mathematical analysis IV - MAT172	**Purpose:** to provide basic knowledge on differential and integral calculus of functions of many variables. **Summary** Differential and integral calculus of a function of many variables. Curvilinear, double and multiple integrals; surface and volume integrals; mean value theorems; Fourier series and integrals.	5	Ability to operate scalar and vector functions; calculate the gradient of a scalar function, divergence and rotor of vector functions; use knowledge of vector analysis and tensor analysis elements to solve problems of mechanics and engineering.

		Applications of differential and integral calculus of functions of many variables in mechanics and engineering.			
19	Equations of mathematical physics – MAT448	**Purpose:** The main topics of the course are: linear and quasi-linear partial differential equations, hyperbolic equations and some methods of their study, elliptic partial differential equations, some qualitative properties of their solutions, weak solutions, classical solutions, Poinre-Perron method, parabolic method. **Summary** Differential and integral calculus of a function of many variables. Curvilinear, double and multiple integrals; surface and volume integrals; mean value theorems; Fourier series and integrals. Applications of differential and integral calculus of functions of many variables in mechanics and engineering.	5		Knowledge of the concepts and ideas of UMF; the ability to build mathematical models of simple engineering problems described by UMF; the ability to select methods sufficient for their research and obtain analytical or numerical results.
20	Engineering and computer graphics - GEN177	**Purpose:** to teach students the methods and means of machine graphics and graphical modeling of geometric objects. **Summary** Concepts of computer graphics, geometric modeling, graphic object, interactive graphic system for solving problems of automation of drawing and graphic works on the example of AutoCAD. Methods of obtaining certain graphical models of space based on orthogonal projection and the ability to solve problems related to spatial forms and relationships on these models.	5		Ability to apply methods of graphical representation of objects of engineering mechanics, mechanical engineering; willingness to use modern means of computer graphics, in engineering mechanics; ability to participate in the development of design and working design documentation in accordance with regulatory documents.

21	Statics and Kinematics GEN409	**Purpose:** familiarization with various properties of forces and conditions of equilibrium, formation of scientific foundations of knowledge of the laws of nature related to the conditions of equilibrium of bodies. **Summary** A system of converging forces. The theory of moments. The main theorem of statics. Arbitrary plane system of forces. Friction. Arbitrary spatial system of forces. The center of gravity of the body. Kinematics of a point. The simplest movements of a rigid body. Plane-parallel motion of a rigid body. Complex point movement.	5	The ability to apply fundamental laws of nature and basic physical laws in the field of mechanics for the study of static problems of engineering mechanics. Ability to build adequate mathematical models of static problems; Analyze the received decisions and draw conclusions and develop appropriate recommendations.
22	Dynamics - GEN198	**Purpose:** familiarization with the main types of motion of mechanical systems and the formation of scientific foundations for the knowledge of the laws of nature related to the movement of material bodies under the action of forces. **Summary** The dynamics of a material point and the dynamics of a solid body. The basic laws of motion and interaction of material bodies. The concept of oscillatory motion of various mechanical systems. Analysis of the conditions of stability of equilibrium and motion of material objects, methods for solving the corresponding equations.	5	The ability to apply fundamental laws of nature and basic physical laws in the field of mechanics for the study of dynamic problems of engineering mechanics. The ability to build adequate mathematical models of dynamics problems. Ability and readiness to solve problems of dynamics by analytical and numerical methods. The ability and willingness to analyze the results obtained and summarize them.

23	Chemistry - CHE495	**Purpose:** formation of knowledge on fundamental issues of general chemistry and skills of their application in professional activity. **Summary** Laws, theoretical propositions and conclusions that underlie all chemical disciplines; properties and relationships of chemical elements based on the periodic law of D.I.Mendeleev and on modern ideas about the structure of matter; fundamentals of chemical thermodynamics and kinetics; processes in solutions; the structure of complex compounds.	5	Ability: to navigate the basic concepts of chemistry, properties of elements-nonmetals and metals of groups of the periodic system; to make chemical equations describing mass transfer processes; make calculations using basic chemical patterns.
24	Theory and Design of Mechanisms and Machines - GEN413	**Purpose:** familiarization with general methods of analysis and synthesis of mechanical systems, mastering general methods of studying the structure, geometry, kinematics and dynamics of typical mechanisms and machines. **Summary** The basic concepts of machine elements and the main types of mechanisms. Structural analysis and synthesis of mechanisms. Kinematic analysis of mechanisms with lower pairs. Dynamics of machines and mechanisms. Synthesis of mechanisms. Designing mechanisms with the required properties.	5	The ability to independently compile structural and kinematic schemes of mechanisms. Possession of general (standard) methods and algorithms for the analysis and synthesis of mechanisms and systems formed on their basis. Willingness to participate in the collection and analysis of initial data for the design of equipment elements and objects of activity in general using regulatory documentation and modern methods of information retrieval and processing.
25	Engineering Thermodynamics GEN199	**Purpose:** familiarization with the basic laws and regulations of thermodynamics in relation to the tasks of power	5	Ability and ability: to carry out thermodynamic calculations of heat exchange systems; to design and select systems for heat supply of buildings and structures;

		engineering and thermal power engineering. **Summary** Basic concepts of thermodynamics. The first law of thermodynamics. Application of the first law of thermodynamics to ideal gases. The second law of thermodynamics. Application of the second law of thermodynamics to analysis. Heat-power gas cycles. Thermodynamic potentials and differential equations of thermodynamics. Properties of real gases and vapors. Cycles of refrigerating machines and heat pumps.		to carry out thermal calculations on licensed software.
26	Numerical Methods and Programming - GEN414	**Purpose:** introduction to the basics of programming, methods and algorithms of calculation, methods of numerical solution of algebraic and ordinary differential equations using computers. **Summary** Algorithms search algorithms, data processing algorithms, arithmetic algorithms. Examples of unstable algorithms and sensitivity of problems to initial conditions. Approximation of functions. Numerical differentiation and integration. Numerical solution of systems of algebraic equations.Numerical solution of ordinary differential equations by Euler and Runge-Kutta methods.	5	Skill: to develop algorithms and programs for solving computational problems; numerically differentiate and integrate analytical or tabular functions; numerically find the roots of equations, the minimum of functions; numerically solve algebraic and systems of algebraic equations; Numerically solve ordinary differential equations using Euler and Runge-Kutta methods.

27	Fluid Mechanics - GEN404	**Purpose:** formation of knowledge on fundamental issues of fluid mechanics and acquisition of skills in applying the acquired knowledge and methods to solve practical engineering problems. **Summary** The continuity hypothesis; hydrostatics. Kinematics of the flow field; conservation of mass. Equations of fluid motion, Bernoulli's theorem. Vortex-free and vortex-free flow of incompressible inviscid fluid. Flows of viscous incompressible fluid. Turbulent flow, calculation methods.	5	Ability: to apply the basic laws of statics, kinematics and dynamics of liquids and gases in solving engineering problems; to distinguish between the modes of fluid flow and to select methods of solution in applied problems for the calculation of the movement of liquids and gases; independently build the appropriate calculation scheme and find the optimal solution to the task.
28	Solid Mechanics - GEN405	**Purpose:** formation of knowledge on the theoretical foundations of deformable solid mechanics, instilling skills in solving practical problems of mechanics and engineering. **Summary** Stress theory. Theory of deformations. The complete system of equations of the theory of elasticity. Methods for solving problems of elasticity theory. The simplest inversely symmetric problems of elasticity theory (torsion of rods). Approximate methods for solving problems of elasticity theory. Axisymmetric problems and non-axisymmetric problems. Theory of bending of thin plates.	5	Ability: to determine stresses, deformations and displacements in a solid elastic body; make calculation schemes; make basic equations and apply methods of elasticity theory to solve applied problems; analyze the stress state at dangerous points and correctly apply the basic hypotheses of the classical theory of elasticity;
29	Numerical Methods for Solving	**Purpose:** introduction to numerical methods for solving equations of matter transfer and stationary and non-	5	Ability: to choose the optimal method of numerical solution of a specific problem of matter transfer and diffusion, problems described by elliptic equations;

	Engineering Problems - GEN415	stationary thermal conductivity in relation to problems of engineering mechanics. **Summary** Finite-difference methods for solving the equation of matter transfer and diffusion. The concept of stability and convergence of the scheme. Explicit and implicit schemes. Iterative methods for solving elliptic equations. Implementation of initial and boundary conditions. Strategy and tactics of numerical solution of engineering mechanics problems.		build a numerical model of the problem; develop a computer program and perform calculations; analyze the results and validate the model, if necessary, adjust the numerical and/or computer models.
30	Design of Mechanical systems GEN-420	**Purpose:** to gain knowledge in the field of engineering design of various types of mechanical systems using modern computer programs. **Summary** The latest computer modeling tools, finite element methods, optimization methods and methods of analysis of many-body systems. Design of mechanical systems using standard packages and computer-aided design tools Stress calculation, evaluation of deflections, static failures, loss of stability of structural elements under combined loads.	5	Having the ability to solve standard problems of engineering mechanics. Ability to model technical objects and technological processes. Knowledge of the methodology for designing mechanical systems using standard packages and computer-aided design tools and the ability to apply them in practice. The ability to use new knowledge and skills in practical activities.
31	Thermal system design – GEN460	**Purpose:** to gain knowledge in the field of designing energy efficient thermal and ventilation systems. **Summary** Design of thermal and ventilation systems: Economic calculations for	5	Ability to apply mathematical methods in system modeling of thermal installations; apply modern computer technologies and programs for the calculation and selection of thermal systems; apply TRNSYS and EES software in the calculation and selection of component equipment for thermal systems;

		engineering systems. Modeling of thermal and ventilation systems. Optimization of thermal and ventilation installations. Mathematical modeling-thermodynamic parameters. Dynamic behavior of thermal and ventilation systems. Solar heating and hot water supply. Heating systems based on renewable electricity.		design thermal systems.
		Cycle of basic disciplines Elective component (Elective)		
32	Statistical Mechanics – GEN185	Objective: to form the scientific foundations of a probabilistic approach to the calculations of structural elements for strength, reliability, stability. Summary Determination of probabilistic characteristics of processes, mastering statistical methods for calculating systems, the main provisions of the theory of random processes, methods for analyzing random oscillations of mechanical systems, drawing up mathematical models for calculating machine elements, mechanisms and machine units under the action of random loads, carrying out calculations of reliability and trouble-free operation of systems.	5	Ability to perform calculations of reliability and uptime of systems; determine the probability of failure-free operation of mechanical systems; formulate your own conclusions and justify them. Ability and willingness to apply practical methods of the fundamentals of statistical mechanics and reliability theory; use the studied material in your subject area; use information technology to solve statistical mechanics problems; analyze the results obtained and summarize them.
33	The Strength and Reliability of Machines - GEN407	Purpose: teaching the basics of the science of strength and reliability of materials, structures and machines, preparing him for the correct choice of calculation and design methods. Summary The main provisions of the science of the strength of materials and	5	Ability to design structures of machines and mechanisms; to analyze the necessary information, technical data, indicators and results of work, their generalization and systematization; to carry out the necessary calculations using modern technical means when calculating the strength and reliability of machines.

		structures, methods of calculation and design for the general case of the action of forces, calculation of statically indeterminate systems, dynamic action of forces, calculation of structural elements beyond the limits of elasticity, positions and dependences of reliability, reliability according to basic criteria, calculations of reliability of machine parts of individual groups.		
Cycle of profile disciplines University component			
34	Strength of Materials - GEN426	**Purpose:** to teach the basics of the science of strength, rigidity and stability of materials and structures, to prepare for the correct choice of calculation methods and design of various structures. **Summary** The laws and theoretical propositions that underlie the mechanics of a deformable solid. Methods of calculation of structural elements for strength, rigidity and stability, methods of calculation and design in the general case of the action of forces, dynamic action of forces, calculation of structural elements beyond elasticity.	5	Proficiency in the experimental study of the mechanical properties of materials, the stress-strain state of the simplest structural elements. Ability to handle modern testing machines and measuring equipment; accurately and thoroughly argue the course of reasoning, without cluttering it with unnecessary details; apply the studied material in various fields of engineering.
35	Engineering Materials - GEN402	**Purpose:** familiarization with the structure and mechanical properties of metallic and non-metallic materials. **Summary** The structure of materials. Crystallization and structure of metals and alloys. Mechanical properties of materials. Diagram of the state of alloys.	5	Knowledge of methods: determination of optimal and rational modes of heat treatment and hardening of materials; analysis of the causes of defects in materials; determination of the quality and condition of alloys based on the analysis of their structures.

		Structure, properties and heat treatment of iron-carbon alloys. Structural and tool steels and alloys. Non-ferrous metals and non-metallic materials.		
36	Machine Element Design - GEN419	**Purpose:** formation of the necessary initial knowledge base on the basics of theory, design calculation, design of parts and elements of machines, development and execution of design documentation. **Summary** The concept of machine parts and elements, the main issues of ensuring their operability. Study of general principles of design and construction, construction of models and calculation algorithms for typical parts and elements of machines, considering the main performance criteria, development of design skills.	5	Ability design elements of machines of the required purpose according to the specified output data; choose the most suitable materials for machine elements and use them efficiently; perform calculations of machine parts and components using reference literature and GOST standards. The ability to collect and analyze raw data for the design of machine elements using regulatory documentation and methods of information retrieval and processing.
37	Fundamentals of mechatronics - GEN444	**Purpose:** 16-bit microprocessor, embedded computers, analog and digital devices, sensors, actuators, modeling and control of electromechanical systems, modeling of various mechatronic systems. **Summary** The concept of machine parts and elements, the main issues of ensuring their operability. Study of general principles of design and construction, construction of models and calculation algorithms for typical parts and elements of machines, taking into account the	4	The ability and ability to design, model and manage modern mechatronic systems.

		main performance criteria, development of design skills.		
38	Basics of heat transfer - GEN418	**Purpose:** to form an idea about the physical nature of heat transfer processes, about theoretical, experimental and computational methods and methods for generalizing the results obtained, obtaining skills for solving applied problems. **Summary** Basic concepts of heat transfer mechanisms. Fundamental principles and laws of heat transfer. The main types and models of heat transfer. The main methods and techniques for calculating heat transfer in energy systems and their application to solve problems of engineering practice.	5	Ability to carry out calculations of the thermal state of structural elements of thermal power devices; identify, formulate and solve problems related to heat transfer; perform calculations of heat transfer in energy systems; independently build a calculation scheme and find the right solution to the task.
39	Introduction to Robotics-- GEN421	**Objective:** to acquire skills in writing equations and programming kinematics, dynamics and sensing of robots, modeling, real-time control of robotic systems and manipulators. **Summary** Methods determination of the position and speeds of the robot links. Coordinate systems of the robot, recording the equations of forward and reverse kinematics of the robot. Recording of differential equations of robot motion, solution in Matlab. Control of the robot by trajectory and by force. Simulation of manipulators and robots.	5	The ability to apply methods for determining the position and speed of robot links in the Matlab environment, for calculating and designing robots. Willingness and ability to use information technologies, including modern computer tools, in robotics. The ability to design new works in mechanical engineering.

				Cycle of profile disciplines Component of choice	
40	The finite element method in engineering-GEN441	**Purpose:** to familiarize with the methodology of performing finite element analysis in the Structure3D automated control system environment. Mastering the creation of an object model in the ARM Strucmrc3D editor and using the three-dimensional ARM Studio editor. **Summary** The basic concept of the FEM. Creation and calculation of models of structures containing rod, plate and volumetric finite elements in ARM STRUCTURE 3D. Using ARM STUDIO to create, load and generate a finite element grid of three-dimensional models. Modules for calculation, analysis and design of shafts and axles.	4	Ability: to choose the type of finite elements with which the real construction will be adequately modeled; to build a model of the projected object in three-dimensional space; to divide the model into finite elements; perform the entire complex of necessary calculations; visualize the results obtained and correctly interpret them in order to make the right design decisions.	
41	Computational hydromechanics -GEN439	**Purpose:** teaching methods of numerical solution of fluid flow problems arising in various engineering devices. **Summary** Fundamentals of finite difference methods. Methods for solving the vortex transfer equation. Explicit and implicit methods, boundary conditions. Numerical implementation of the solution of the vorticity transfer equation. Methods for solving equations for the current function are direct and iterative methods, boundary conditions. Numerical implementation of the	4	The ability to independently master and apply computational methods and computer-aided design for the effective solution of professional tasks; ability to apply modern methods of computational fluid dynamics to solve engineering problems; the ability to analyze the results and their generalization, and systematization, to carry out calculations using modern software packages to solve a wide range of engineering problems.	

		vorticity – current function equations. Finite–difference methods for solving the Navier–Stokes equations for physical variables.			
42	Dynamics of machines and its computer analysis-GEN159	**Purpose:** formation of ideas about the dynamic processes that take place during the operation of machines and mechanisms and taking them into account in the design. **Summary** Equivalent circuits and mechanical characteristics of machines and their drives. Laws of motion of machines with various mechanical characteristics. Questions of the theory of dynamics of machines with concentrated and distributed parameters. Ways to reduce dynamic loads. Computer analysis and synthesis of dynamic systems using the MATHCAD mathematical package.	5		The ability to apply theoretical, computational and experimental research methods, methods of mathematical and computer modeling in the process of professional activity. Knowledge of modern methods and means of conducting experimental research on dynamics and strength, stability, reliability, friction and wear of machines and devices.
43	Dynamic systems management - GEN189	**Purpose:** teaching the basics of the theory of control of dynamic systems. **Summary** Theory of management of technical objects, challenges dictated by the nonlinear dynamics of management processes, priority tasks and approaches to their solution. The development of control theory in the context of three periods of its formation: the period of classical Newton mechanics, the modern period and in the direction of the future role of control theory as a component of the process of creating self-managed	5		Умение Управление динамическими системами: Теория управления техническими объектами, вызовы, диктуемые нелинейной динамикой процессов управления, приоритетные задачи и подходы к их решению. Развитие теории управления в контексте трех периодов её становления: периода классической механики Ньютона, современного периода и в направлении будущей роли теории управления как составляющей процесса создания самоуправляемых объектов и технологий.

		objects and technologies.		
44	Machine Learning in Engineering - GEN190	**Purpose:** to familiarize with the basics of machine learning and its application in stochastic engineering problems. **Summary** Linear classifier and stochastic gradient. Neural networks: gradient optimization methods. Metric methods of classification and regression. The method of support vectors. Multidimensional linear regression. Nonlinear regression. Model selection criteria and feature selection methods. Logical classification methods. Deep neural networks. Neural networks with unsupervised learning.	5	Ability Machine learning in Engineering: Basic concepts and examples of applied tasks. Linear classifier and stochastic gradient. Neural networks: gradient optimization methods. Metric methods of classification and regression. The method of support vectors. Multidimensional linear regression. Nonlinear regression. Model selection criteria and feature selection methods. Logical classification methods. Deep neural networks. Neural networks with unsupervised learning.
45	Computational mechanics - GEN425	**Purpose:** to teach the construction of computer models of mechanical systems, numerical solution of continuum mechanics problems, computer engineering calculations of mechanics problems.	5	Ability The purpose of the discipline is to prepare specialists for the construction of computer models of mechanical systems, numerical solution of continuum mechanics problems, computer engineering calculations of mechanics problems.
46	3D printing of machine parts and elements – GEN438	**Purpose:** to familiarize students with the basics of additive technology and the main types of AI technologies. **Summary** The study of terminology and classification, characteristics of the AM technology market. Additive technologies and rapid prototyping, technologies and machines for growing metal products. Additive technologies and foundry, additive technologies and	6	Ability When compiling the program for this course, the following goals were considered: to familiarize students with the classification of additive technologies, to give general information about the main types of AM technologies, manufacturers of AM machines, development trends and examples of practical use of AM technologies in industry. The study of terminology and classification, characteristics of the AM technology market. Additive technologies and rapid prototyping, technologies and machines for growing metal products. Additive technologies and foundry, additive technologies and powder metallurgy, creation of machine elements.

		powder metallurgy, creation of machine elements.		
47	Mechanics of biofluids - GEN442	**Objective:** to study the structure, function and movement of mechanical aspects of biological systems using methods of mechanics. **Summary** Rheological properties of blood and issues of its modeling, biomechanics of large blood vessels, anatomy and histology of vessels, mechanical properties of biological tissues, features of the functioning of the vascular system in a living organism. Research and modeling methods.	6	Ability Rheological properties of blood and issues of its modeling, biomechanics of large blood vessels, anatomy and histology of vessels, mechanical properties of biological tissues, features of the functioning of the vascular system in a living organism.
48	Design of thermal and ventilation systems – GEN445	**Purpose**: to gain knowledge in the field of designing energy efficient thermal and ventilation systems. **Summary** Design of thermal and ventilation systems: Economic calculations for engineering systems. Modeling of thermal and ventilation systems. Optimization of thermal and ventilation installations. Mathematical modeling-thermodynamic parameters. Dynamic behavior of thermal and ventilation systems. Solar heating and hot water supply. Heating systems based on renewable electricity.	6	Ability Engineering design. Design of working systems. Economic calculations for engineering systems. Modeling of thermal systems. System modeling of thermal installations. Optimization of thermal installations. Mathematical modeling-thermodynamic parameters. Dynamic behavior of thermal systems. Modeling using methods of probability theory. Solar heating and hot water supply. Heating systems based on renewable electricity.
49	Renewable energy systems - GEN446	**Purpose:** formation of knowledge in the field of renewable energy sources and training in the skills of their use. **Summary**	6	Ability The volume of reserves of traditional energy carriers. Nuclear energy and the greenhouse effect. Solar radiation. Wind energy. Water energy.

		The volume of reserves of traditional energy carriers. Nuclear energy and the greenhouse effect. Solar radiation. Wind energy. Water energy. Geothermy. Use of biomass. Hydrogen production, fuel cells and methanization.		Geothermy. Use of biomass. Hydrogen production, fuel cells and methanization.