N-PJSC "KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY NAMED AFTER K.I. SATPAYEV"

«Approved»
Director of GMI
_____ K.B.Rysbekov
«___» _____ 2025 г.

GRADUATE MODEL (BACHELOR)
Educational program

6B07303 - Geospatial Digital Engineering
(B074 – Urban Planning, Construction, and Civil Engineering)

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Content

Introduction

The specialist's model should be systemic in nature, reflect the advantages of qualification and competence approaches.

In the competence model of a specialist, the goals of education are associated not only with the performance of specific functions, but also with integrated requirements for the outcome of the educational process. The competence approach covers, along with specific knowledge and skills, categories such as the ability and willingness to learn, social skills, etc.

Modern conditions impose new requirements on graduates in the field of geospatial digital technologies, geodesy and cartography, among which the requirements of systemically organized, intellectual, communicative, self-organizing principles receive increasing priority.

The quality of bachelor's professional training in geodesy and cartography depends on the degree of validity of three main points:

- • Goals and objectives of the educational program .
- • The content of the training.
- • Principles of the educational process organization.

Taking into account the opinion of potential consumers and the association of graduates of KazNTU named after K.I.Satpayev, in accordance with the mission of the University and the requirements of the State Mandatory Standard of Education of the Republic of Kazakhstan, the goals and objectives of the educational program of the specialty 6B07303 – Geospatial digital Engineering were formulated and approved by the Academic Council of the Mining and Metallurgical Institute.

The content of the training should meet the requirements of the current level of development of Geodesy, Cartography, geoinformatics, mastered by the bachelor throughout the training.

The competence matrix is a tool for determining the minimum abilities of a bachelor of the educational program of specialty 6B07303 - Geospatial Digital Engineering. The structure of the matrix allows you to evaluate the minimum competence necessary for the entire career growth. It is also used to approve future industrial standards and can be used by companies to evaluate their personnel.

The model of a specialist in the field of geospatial digital technologies provides for:

- competencies due to the development of modern science and technology;
- competencies dictated by the requirements of the profession, specialty;
- competencies determined by the socio-political system of the country, its spiritual and moral system.

The model of a specialist in the field of geodesy and cartography has

historically been embodied in various forms: qualification characteristics and professionograms.

To acquire a set of professional, intercultural, communicative competencies, a graduate of OP 6B07303 Geospatial Digital Engineering (geodesy and cartography) must master the knowledge of a set of general education (OOD), basic (DB) and profile (PD) disciplines, both their mandatory component and the component of choice in full, established by the state standard.

Of great importance in the modern world is the ability to navigate the information flow: the ability to find and systematize various sources of information according to a certain criterion; use rational methods of obtaining, converting, systematizing and storing information, actualize it in the necessary situations of intellectual and cognitive activity, as well as computer literacy, knowledge of new information and multimedia technologies, the ability to critically evaluation of information.

Purpose: The purpose of the educational program is to prepare a graduate as a competitive specialist in the field of geodesy and cartography, possessing critical thinking, able to use theoretical and practical information to perform geodetic, topographic, astronomical-geodetic, photogrammetric and cartographic work using modern geodetic equipment and geospatial digital technologies to solve applied problems.

A graduate in the field of geodesy and cartography should be ready for:

- organizational activities that exclude negative phenomena in professional activity, the development of spiritual values, moral and ethical norms of the individual as a member of society, the implementation of the legal and legislative system of the Republic of Kazakhstan with a high level of professional culture, citizenship;
- activities for continuous self-improvement and self-development, mastering new knowledge, skills and abilities in innovative areas of geodesy and cartography;
- acquisition of competencies for performing calculations of elements in geodesy and cartography, design of technical solutions, participation in the development of technical tasks for topographic, geodetic, aerospace, cartographic work;
- competitiveness in the field of geodesy and cartography by increasing competence in the field of advanced technologies of geodesy, cartography.

1. Objectives and Tasks of the Educational Program

Objective: The objective of the educational program is to prepare graduates as competitive specialists in the field of geodesy and cartography, equipped with critical thinking skills and the ability to apply theoretical and practical knowledge to perform geodetic, topographic, astronomical-geodetic, photogrammetric, and cartographic tasks using modern geodetic equipment and geospatial digital

technologies to solve applied problems.

A graduate in the field of geodesy and cartography should be prepared for:

- organizational activities that prevent negative phenomena in professional practice, promote the development of spiritual values and moral-ethical norms of the individual as a member of society, and ensure adherence to the legal and legislative system of the Republic of Kazakhstan with a high level of professional culture and civic responsibility.

- engaging in continuous self-improvement and self-development, acquiring new knowledge, skills, and abilities in innovative areas of geodesy and cartography;

- gaining competencies for performing calculations of elements in geodesy and cartography, preparing technical documentation, and participating in the development of technical specifications for topographic-geodetic, aerospace, and cartographic works;

- ensuring competitiveness in the field of geodesy and cartography by enhancing expertise in advanced geodetic and cartographic technologies.

2 List of qualifications and positions

A graduate of the Bachelor's degree in OP 6B07303 - "Geospatial Digital Engineering" is awarded an academic bachelor's degree in geospatial digital technologies.

Qualifications and positions are determined in accordance with the National Qualifications Framework (NQF) approved by the Protocol of March 16, 2016 by the Republican Tripartite Commission on Social Partnership and Regulation of Social and Labor Relations.

A graduate who has mastered the program in the field of training, in accordance with the types of professional activity, is ready to solve the following professional tasks:

research activities:

– carrying out a planned survey on the ground, determining the position of points on the earth's surface relative to local reference points for drawing up topographic maps necessary for the construction and compilation of the land cadastre;

– conducting surveys on a national scale, the area and shape of the surface are determined in relation to the global reference network, taking into account the curvature of the Earth's surface;

– conducting global surveys, studying the shape of the Earth and planets, the gravitational field of the Earth;

production and technological activities:

- implementation of angular, linear, satellite measurements in state and special networks;
- carrying out leveling works of all classes;
- conducting topographic and special surveys of various scales;
- cartographic support of territorial planning and management of production placement, defense needs of the country, protection and rational use of natural resources, in the implementation of environmental programs;
- mathematical and computer processing of geospatial data using GIS;
- compilation, editing and publication of maps;

organizational and managerial activities:

- organization, planning and management of geodetic and cartographic works, in order to create and update maps and plans, geodetic networks;
- organization, planning and management of engineering and geodetic works in the construction of buildings and structures;

design and survey activities:

- work on the organization and rationing of labor in the field of geodesy and cartography;
- preparation of design and estimate documentation for the production of geodetic, cartographic, photogrammetric and topographic works.

Types of professional activity

-Bachelors of OP 6B073303 - "Geospatial digital engineering" can **perform the following types of professional activities:**

Experimental research;
- Production and technological;
- Organizational and managerial;
- Design and analytical;

3 Descriptors

The sphere of professional activity is all branches of the economy, including military, aerospace and industrial complexes, civil and industrial construction, engineering surveys, state bodies in the field of land management.

The objects of professional activity are: the surface of the Earth, state geodetic networks and special purpose networks; construction sites of buildings and structures; civil, residential, transport, hydraulic engineering buildings and structures; mineral deposits; land plots, urban areas, natural and natural-anthropogenic systems.

The subjects of professional activity are geodesy; cartography; applied geodesy; geodetic tools; modern geodetic equipment; higher geodesy; technology for creating digital maps; engineering and geodetic surveys; geodesy in construction; organization and planning of cartographic and geodetic works; photogrammetry; remote sensing; aerospace survey methods; geodetic and

cartographic software products.

Bachelor's Degree structure

4 General competencies

4.1 Social and humanitarian

Knowledge of the laws of socio-economic development of society, the history of Kazakhstan, the state language, foreign and Russian languages as means of interethnic communication.

Understanding the importance of their social functions as a citizen of their country, a member of society, a stable positive attitude to their public duties. Knowledge of the symbols of the state (coat of arms, flag, anthem).

Knowledge of human and civil rights and freedoms, the ability to implement them in various life situations. The ability to correlate their interests with the interests of society. The focus on the improvement and development of society based on the principles of humanism, freedom and democracy. Experience of socially useful civic activity. The presence of a certain life position and internal readiness for its implementation. The ability to take responsibility, participate in the functioning and improvement of democratic institutions. The need for self-development.

Knowledge and observance of the principles of a healthy lifestyle, physical well-being, and the ability to make responsible and free choices regarding one's way of life.

A graduate should possess a culture of thinking, understand its general laws, and be able to properly and logically present results in both written and oral form. Knowledge and observance of traditions, rituals, and etiquette.The ability to engage in constructive communication and maintain its optimal duration; the ability to conduct a civilized dialogue. Knowledge of constructive methods for resolving conflicts and restoring disrupted relationships. A critical attitude toward oneself and one’s interlocutor, along with the ability to recognize one’s own mistakes and acknowledge when one is right.

Economic and Organizational-Managerial Competencies

A graduate should have knowledge of the fundamentals of production relations and management principles, taking into account technical, financial, and human factors.They should possess the basics of economic analysis and be prepared to perform organizational and managerial functions within a team.

General Scientific Competencies

Provision of in-depth knowledge in natural sciences and general technical subjects as a foundation for professional education. This is achieved through the study of disciplines such as Higher Mathematics (differential and integral calculus, mathematical statistics), Physics, Chemistry, Descriptive Geometry, and Computer Graphics.General scientific competencies also include information literacy: computer proficiency, mastery of new information and multimedia technologies

(email, internet), and the ability to critically assess information. The graduate should be able to navigate information flows: find and systematize various sources of information based on specific criteria; apply rational methods for obtaining, processing, organizing, and storing information; and use it effectively in relevant situations related to intellectual and cognitive activities.

General Technical Competencies

A bachelor's degree graduate must be competent in all matters related to the stages of the technological process, occupational safety in production, and environmental protection.

This competency is developed through the study of disciplines such as: Thermodynamics and Heat Transfer, Computer Science, Applied Mechanics, Strength of Materials, Ecology and Sustainable Development, Fundamentals of Design and Machine Elements, Materials Science and Technology of Structural Materials, Friction and Wear, Electrical Engineering, and Hydraulics.

The professional capabilities of a bachelor in today's conditions must meet the demands of the global and international labor market. The graduate should be prepared to adapt to changing social, economic, and professional roles, and be geographically and socially mobile in a world of increasing dynamism and uncertainty.

5. Professional Competencies

The goal of the cycle of core professional disciplines (PD) is to study the key theoretical aspects of engineering and technology in the field of geodesy and cartography in order to solve professional tasks related to: research and scientific activities, production and technological activities, organizational and managerial activities, design and surveying activities.

Research and Scientific Activities:

- conducting planned surveys in the field to determine the location of points on the Earth's surface relative to local reference points for the creation of topographic maps, which are essential for construction and land cadastre development;
- conducting large-scale surveys at the national level, where the area and shape of the surface are determined in relation to the global reference network, taking into account the curvature of the Earth's surface;
- conducting global surveys, studying the shape of the Earth and other planets, as well as the Earth's gravitational field.

Production and Technological Activities:

- carrying out angular, linear, and satellite measurements within national and specialized geodetic networks;
- performing leveling works of all classes;
- conducting topographic and specialized surveys at various scales;

providing cartographic support for territorial planning and production placement management, national defense needs, environmental protection, and the rational

use of natural resources, as well as the implementation of ecological programs;
- performing mathematical and computer-based processing of geodetic measurement results;
- compiling, editing, and publishing maps.

Organizational and Managerial Activities:

- organizing, planning, and managing geodetic and cartographic works aimed at the creation and updating of maps, plans, and geodetic networks;
- organizing, planning, and managing engineering and geodetic operations during the construction of buildings and structures.

Functions of Professional Activity

- In their professional practice, a bachelor performs the following functions:
- preparing technical documentation and required reports in accordance with approved formats;
- conducting training and briefings on occupational safety, labor protection, and environmental protection;
- ensuring compliance with requirements for the preparation of cartographic and geodetic documentation.

Typical Tasks of Professional Activity

Professional competencies and skills are defined by the following areas of professional activity:

- readiness to perform geodetic surveying of buildings, structures, and utilities; to create topographic maps in digital format using geodetic information systems and graphic processing software;
- ability to develop algorithms, software, and methodologies for solving tasks in geodesy and remote sensing; to calibrate and adjust the primary instruments and equipment used in geodesy, cartography, land management, and cadastre; knowledge of the principles for using, maintaining, transporting, and storing instruments, equipment, and materials; raster map image transformation and registration, and vectorization of raster topographic maps within geodetic information systems;
- ability to organize and conduct experiments, process, summarize, analyze, and present the obtained results; compile catalogs and coordinate/height lists of points; prepare diagrams of traverses and geodetic networks; and fill the topographic database with digital information for the mapped area;
- ability to compile master copies of topographic (geographic) bases in a specified projection and coordinate system; to process satellite and aerial photogrammetric materials, as well as field journals using computer software;
- ability to study and model the physical fields of the Earth and planets; to evaluate the results of the processing of theodolite traverse data; to analyze and assess the outcomes of leveling computations; and to provide geodetic support for the construction and operation of engineering structures.

Areas of Professional Activity

The areas of professional engagement, according to the level and specialization of acquired skills and the type of work performed, include: GIS centers; the military industry; corporations involved in the extraction of solid minerals; oil and gas companies; land and cadastral authorities; construction organizations.

Content of Professional Activity

The content of the educational program 6B073303 «Geospatial Digital Engineering,» based on the development of a multi-level system of personnel training, the fundamental nature and quality of education, continuity and succession of education and science, as well as the integration of education, upbringing, research, and innovation, should be aimed at meeting the needs of consumers to the fullest extent and must ensure:

- acquisition of a complete and high-quality professional education in the field of geodesy and cartography, confirmed by the level of knowledge, skills, abilities, and competencies, in accordance with the criteria established by the State Educational Standards, evaluated both in content and in volume;
- training of professional and competitive specialists in the field of geodesy and cartography;
- ability to apply knowledge of mathematics, fundamental and technical sciences;
- use of methods for analyzing and evaluating the results of experiments;
- ability to apply methods, skills, and modern technical tools required for practical engineering activities in the field of geodesy and cartography;
- ability to find and work with the necessary literature, computer-based information, databases, and other sources to solve assigned tasks;
- development of teamwork skills, professional and ethical responsibility, the ability to understand problems and collaboratively work with specialists from various fields to find solutions, and a desire for continuous improvement of one's knowledge and expertise.
- ability to work in a team on interdisciplinary topics while demonstrating individuality, and, when necessary, independently solving problems;
- readiness of students for professional activity through disciplines that provide fundamental knowledge, skills, and practical abilities for work in industry, government institutions, and educational organizations;
- ability to conduct analysis and monitoring, and to make managerial decisions based on the results;
- possessing broad knowledge and understanding of contemporary social and political issues; proficiency in the state language (Kazakh), Russian, and foreign languages; familiarity with market economy tools, and awareness of safety and environmental protection issues.

The educational program is also aimed at training specialists capable of applying geospatial technologies to achieve the Sustainable Development Goals (SDGs). Special attention is given to skills in environmental change monitoring

using remote sensing data, the creation of digital twins of territories and 3D models, and ensuring sustainable design and operation of infrastructure facilities.

Requirements for the Bachelor's key competencies in OP 6B07303 – «Geospatial digital Engineering»

A bachelor should have an idea about:

- the shape and size of the Earth;
- coordinate systems;
- plans, maps, profiles;
- scale, terrain, angular and linear measurements;
- altitude measurements;
- methods and measurements of topographic surveys;
- accuracy of geodetic measurements.

To know:

- mathematical basis of maps and types of cartographic projections;
- cartographic methods of relief image;
- the main sources for the compilation of thematic and general geographic maps;
- methods of creating maps in software products;
- methods of geodetic works when accompanying the design, construction and operation of engineering structures;
- composition and organization of geodetic works in the design of structures;
- methods of equalization of geodetic networks;
- methods of creating digital and electronic maps;
- development processes of digital maps and technological schemes of their interaction;
- types of topographic and geodetic works performed to ensure the design, construction and reconstruction of various structures, as well as to perform geological, hydrometeorological and other types of engineering surveys.

be able to:

- use elements of probability theory and mathematical statistics to assess the quality of geodetic measurements performed;
- perform analysis of natural and socio-economic systems through computer modeling based on geographic information systems (GIS);
- to form databases and design specialized GIS;
- perform geodetic measurements using modern geodetic instruments;
- process the results of geodetic measurements using software products;
- build topographic plans and terrain profiles;
- perform geodetic measurements when creating a planned, high-altitude justification for the design of engineering structures;
- take pictures of linear structures and underground utilities;
- process the results of geodetic measurements and topographic surveys in order to build engineering plans and terrain profiles.

- **have skills in:**
- description of the mapped objects and the relationship of the terrain objects in the form of their combinations, intersections and neighborhood;
- using the basics of computer networks and the mechanisms of their operation, and analyze the principles of GIS servers
- carrying out topographic surveys using ground-based laser scanning,
- the introduction of UAVs for the effective acquisition of geodetic data,
- the use of satellite technologies;
- processing of aerospace images using various software products;
- creation of orthophotoplans, digital models of terrain and relief;
- performing photogrammetric image processing in the ENVI program,
- performing image classification in the ArcGIS and QGIS software, and
- processing of UAV data in the Agisoft program.
- **be competent:**
- in the field of geodesy and cartography;
- in the field of labor legislation of the Republic of Kazakhstan.

The main national goals of education and the hierarchy of goals (by cycles of disciplines)

Bachelor's degree in OP 6B07303 – «Geospatial digital Engineering» pursues the following goals:

- to implement democratic principles of educational process management in practice, to expand academic freedom and opportunities of higher educational institutions;

-to ensure the adaptation of higher education in the specialty and scientific research to the changing needs of society and the achievements of scientific thought;

- to ensure recognition of the level of training of specialists in other countries;

-to ensure higher mobility of graduates in

changing labor market conditions.

The purpose of the cycle of general education disciplines (OOD) is to provide social and humanitarian education based on knowledge of the laws of socio-economic development of society, the history of Kazakhstan, modern information technologies, the state language, foreign and Russian languages as means of interethnic communication.

The purpose of the cycle of basic disciplines (OD) is to provide in-depth

knowledge of a natural science, general technical and economic nature as the foundation of professional education.

The purpose of the cycle of profile disciplines (PD) is to study the key theoretical aspects of engineering and technology in the field of geodesy and cartography for solving professional tasks in the field of research activities; production and technological activities; organizational and managerial activities; design and survey activities.

Requirements for the level of education of graduates

Requirements for general education

The main requirement for general education is that a graduate receives a full-fledged and high-quality professional education, confirmed by the level of knowledge, skills, skills and competencies, based on the criteria established by the state mandatory standard, their assessment both in content and volume.

Requirements for social and ethical competence

The graduate must possess a humanitarian culture, ethical and legal norms of relations to man, society and the environment, a culture of thinking.

Requirements for economic and organizational and managerial competencies

The graduate must master the basic laws of economic development, factors affecting the technical and economic efficiency of production, knowledge of sociology and psychology in enterprise management, the ability to qualitatively and quantitatively substantiate management decisions.

Requirements for professional competence

The graduate must have professional knowledge in his subject area, know the basics of industrial relations and management principles, taking into account technical, financial and human factors.

The graduate must have a knowledge system for creating and application of modern technologies in his subject area, as well as in related fields; in accordance with his chosen educational trajectory and field of activity, he must have sufficient knowledge, skills, skills and competencies for competent formulation and solution of cartographic and geodetic tasks in his subject area.

Requirements for readiness to change social, economic, professional roles, geographical and social mobility in conditions of increasing dynamism of changes and uncertainties

The professional capabilities of a bachelor specialist in modern conditions must meet the requirements of the global international labor market. A bachelor specialist should be ready to change social, economic, professional roles, should be geographically and socially mobile in the conditions of increasing dynamism of change and uncertainty.

Requirements for education in the main cycles of academic disciplines

The requirements for education in the main cycles of academic disciplines are determined by the specific content of the working curricula of the educational program. In order to acquire a complex of professional, intercultural, communicative competencies, a graduate must master the knowledge of a set of general education (OOD), basic (DB) and profile (PD) disciplines as their mandatory component, and a component of choice in accordance with the chosen trajectory of education in full (at least 135 credits), established by this state standard.

6 Expected results by years of study:

1 year of study

The formation of the personality, ethical and legal foundations of the behavior of the student is carried out. The general provisions of the laws of socio-economic development of society, the history of Kazakhstan are being radically consolidated, knowledge of the state language, foreign and Russian languages is being improved and deepened (to a professional level). Happens
further improvement of the apparatus of mathematical analysis and skills in natural science disciplines, the development of elements of computer graphics and the logical apparatus of descriptive geometry is underway for further transition to a deeper study of general scientific and general technical disciplines.

2 year of study

There is a further formation of the fundamental foundations of technical knowledge for this profession on the basis of an in-depth study of applied mathematics and a deeper study of general scientific and general technical disciplines.Information competence is being strengthened: computer literacy, mastery of new information and multimedia technologies. Masters the basics of industrial relations and management principles, taking into account technical, financial and human factors, the basics of economic analysis. The skills and abilities acquired in the study of surveying drawing, mining graphics, computer graphics are a necessary basis for studying special disciplines and mastering modern calculation methods. The practice conducted by students in the workplace contributes to their acquisition of the necessary production skills.

3 year of study

The study of third-year disciplines provides deep theoretical knowledge of basic and specialized disciplines and is one of the stages of preparation for professional activity. Specialized disciplines allow students to master modern methods and techniques of cartographic and geodetic works using high technologies and the latest software developments. Practical training as a surveyor, cartographer will allow you to master the main production processes.

4 year of study

This course is the main one in training a specialist who meets the requirements of modern production. As a result of mastering specialized disciplines, the student is prepared both theoretically and practically to perform cartographic and geodetic works in all spheres of economic activity. At the pre-graduate practice, the student collects, analyzes and develops the material on the instructions of the supervisor

Conclusion

Thus, in the competence model of a specialist, the goals of education are

associated not only with the performance of specific functions, but also with integrated requirements for the outcome of the educational process. This approach covers, along with specific knowledge and skills, categories such as the ability and willingness to learn, social skills, etc.

Today, responsible decision-making in the field of geodesy and cartography takes place in complex dynamic conditions, so the competencies of a modern specialist can be interpreted in the context of modern theory of self-organization, where they act as an important personal resource. Market conditions impose new requirements on graduates, among which the requirements of systemically organized, intellectual, communicative, self-organizing principles receive increasing priority.