MINISTRY OF EDUCATION AND SCIENCE
OF THE REPUBLIC OF KAZAKHSTAN

Al-Farabi Kazakh National University

Faculty of Physics and Technology

Department of Theoretical and Nuclear Physics

EDUCATIONAL PROGRAM
for specialty 5B071600 - Instrument making

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CONTENTS

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1. Application area

This educational program for the specialty “Instrument making” was developed on the basis of the Standard Curriculum for the specialty 5B071600 - Instrument Making (August 16, 2013 with changes of July 5, 2016) in accordance with international documents in higher education, recommendations of the ECTS Users' Guide (Guidance on the use of ECTS), “Tuning Educational Structures in Europe” and sets the requirements for the content of education through learning outcomes, volume of study load and level of professional training of bachelors.

The educational program was developed taking into account the comparison of the workload of the academic load in accordance with the requirements of the Bologna Declaration.

2. Normative references

1. The Law of the Kazakhstan Republic "On Education" (No. 319-III from July 27, 2007 in the edition of the Law of the Republic of Kazakhstan dated 24.10.11 No. 487-IV, with amendments and additions as of July 4, 2013);
2. The state general compulsory standard of higher education, approved by the Decree of the Government of the Republic of Kazakhstan dated August 23, 2012 No. 1080, as amended on May 13, 2016 No. 292;
3. Typical curriculum on specialty 5B071600 - Instrument Making approved by order of the Minister of Education and Science of the Republic of Kazakhstan dated August 16, 2013 No. 343, as amended on July 5, 2016 No. 425;
4. The Rules for the organization of the educational process on the credit technology of education, approved by the Order of the Minister of Education and Science of the Republic of Kazakhstan dated April 20, 2011 No. 152;
5. The National Framework of Qualifications, approved by the Protocol of the Republican tripartite commission on social partnership and regulation of social and labor relations dated March 16, 2016;
6. Model curricula of the cycle of general education disciplines for organizations of higher and (or) postgraduate education, approved by Order No. 603 of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018;
7. Guidance on the use of the European Credit Transfer and Accumulation System (ECTS), developed as part of the Bologna process and officially published by the European Commission in 2009.
8. Guidelines and advisory regulatory documents of the International Atomic Energy Agency (IAEA):
   - Standards on nuclear safety;
   - Nuclear Infrastructure Review Mission - October 31 to November 7, 2016
9. The concept of development of the uranium industry and nuclear energy of the Republic of Kazakhstan for 2002-2030.

3. Main terms and abbreviations

In this document, the following basic terms and definitions are used in

accordance with the Law of the Republic of Kazakhstan “On Education”, the State General Compulsory Educational Standard (SGCES) of the Republic of Kazakhstan “Higher Education. Undergraduate. Basic Regulations” No. 292 dated 05.13.2016 and SGCES of RK 5.05.001-2005 “ Coding System of Academic Disciplines of Higher and Postgraduate Education ”, international documents in the field of education, European Credit Transfer System:

education – a continuous process of upbringing and education, carried out for the purposes of moral, intellectual, cultural, physical development and the formation of professional competence;

bachelor's program – higher education, educational programs of which are aimed at training personnel with the award of a bachelor's degree in the relevant specialty;

bachelor – the degree awarded to persons who have mastered the educational programs of higher education;

educational program (EP) – a single complex of basic characteristics of education, including the goals, results and content of education, the organization of the educational process, the approaches and methods for their implementation, the criteria for assessing the learning outcomes;

student-centered learning – an approach to learning, characterized by innovative teaching methods, with the aim of facilitating learning through communication of the teacher and the student;

competences – the ability of students to the practical application of acquired in the process of learning knowledge, abilities and skills in professional activities;

professional competences – knowledge, abilities and skills necessary for the effective implementation of professional activities;

descriptors – a description of the level and amount of knowledge, abilities, skills and competencies acquired by the students upon completion of the educational program of the appropriate level of higher and postgraduate education; descriptors are based on the learning outcomes, the formed competencies, as well as the total number of credits;

learning outcomes – the confirmed by the assessment amount of knowledge, abilities and skills, acquired and demonstrated by students after mastering of the educational program, and the formed values and attitudes;

credit technology of education – training based on the selection and self-planning by the students of the sequence of studying disciplines with the accumulation of academic credits;

academic credit – a unified unit of measurement of the volume of scientific and (or) educational work (load) of the student and (or) teacher;

standard curriculum (SC) – a training document developed on the basis of the qualifier of specialties of higher and postgraduate education of the Republic of Kazakhstan and SGCES, regulating the structure and volume of the educational program by the cycles of disciplines, indicating the list of the credits minimum amount for the disciplines of obligatory component and all types of practices, the final certification, approved by the authorized body in the field of education;

obligatory component (OC) – a list of academic disciplines and the corresponding minimum amounts of credits established by the standard curriculum and studied by the students on a mandatory basis under the educational program;

elective disciplines – the academic disciplines that are a elective component within the framework of the established credits and introduced by the educational organizations, reflecting the individual training of the student, taking into account the specifics of social and economic development and the needs of a particular region, the developed scientific schools of the higher educational institution;

curriculum – a document regulating the list, consistency, volume (labor intensity) of academic subjects, academic disciplines and (or) modules, professional practice, other types of educational activities of students of the appropriate level of education and forms of control;

module – a course system in which each course corresponds to an equal number of credits or a multiple of it;

prerequisites – disciplines containing the knowledge, abilities and skills necessary to master the discipline under study;

postrequisites – disciplines for the study of which requires knowledge, abilities and skills acquired at the end of the study of this discipline;

working curriculum (WC) – a training document developed by an educational organization independently on the basis of a standard curriculum of a specialty and individual curricula of students;

intermediate certification of the students – a procedure conducted to assess the quality of students mastering the content of the part or all volume of one academic subject, one academic discipline and (or) module, as well as the professional modules within one qualification after completing their study;

final attestation of the students – a procedure carried out to determine the degree of their mastering the volume of subjects, the educational disciplines and (or) modules stipulated by the state general compulsory standard of the corresponding level of education;

assessment methods – a full range of written, oral and practical tests/exams, projects, presentations, presentations and portfolios, which are used to assess student progress and confirm the achievement of learning outcomes for the educational component (unit/module);

assessment criteria – a description of what a student should be able to do and at what level in order to demonstrate the achievement of the learning outcome;

academic mobility – moving of the students or research teachers to study or conduct research for a specific academic period (semester or academic year) to another organization of higher and (or) postgraduate education (domestically or abroad) with mandatory recalculation of mastered curricula, disciplines in the form of academic credits in their own organization of higher and (or) postgraduate education or for continuing their studies in another organization of higher and (or) postgraduate education;

coding system – a complex of methods and coding rules for classification groups and objects of classification of a given set;

European Credit Transfer and Accumulation System (ECTS) – a student-centered system for the accumulation and transfer of credit based on the principle of transparency in the processes of study, teaching and evaluation.

In addition to these, the following abbreviations are applied:

GED – general educational disciplines;

BD – basic disciplines;

PD – profile disciplines;

OC – obligatory component;

EC – elective component;

EEEA – external evaluation of educational achievements;

SSS – self-study of students;

SSST – self-study of students under the teacher guidance.

4. Main provisions

4.1 The educational program on the specialty "Instrument making" was developed in accordance with the State General Compulsory Educational System of the Republic of Kazakhstan, the National Qualifications Framework and is coordinated with the Dublin descriptors and the European Qualifications Framework. The educational program is focused on the learning outcomes.

4.2 Priority guidelines for the development of the educational program in the specialty "Instrument making" were:

– programs within the framework of the President's Messages, including the messages "The Third Modernization of Kazakhstan: Global Competitiveness", "Digital Kazakhstan" voiced in the text;

– interdisciplinary programs;

– training programs in English language;

– joint educational programs with the foreign partner universities;

– professional programs by order of the enterprises-employers;

– programs, using distance learning technologies, including additional education programs.

4.3 Educational activity at the university is carried out by the credit technology of education on the basis of the student-centered approach, in which the learning outcomes and competences play the main role and become the main result of the educational process for the student. To achieve this goal, the innovative teaching methods should be applied, for example:

– *work in the small groups (team)* - a joint activity of the students in a group under the leadership of a leader, aimed at a common task solving by creatively combining the results of individual work of the team members with the division of powers and responsibilities;

– *project technology* - individual or collective activities at the selection, distribution and systematization of material on a particular topic, as a result of which a project is drawn up;

– *case study analysis* - analysis of the real problem situations that took place in the relevant area of professional activity, and the search for options for the best solutions;

– *role-playing and business games* - role-playing imitation by the students of the real professional activities with the performance of the specialist functions at the various workplaces;

– *advanced independent work* - study of new material by the students before studying it in the classroom;

and others.

4.4 The educational program is intended to provide the high quality of professional education in mechanics in accordance with the highest academic standards in the world educational space.

The program has theoretical and practical components. Terms of study: 4 years. Form of training: full-time. During the period of study, the student learns 151 credits, including theoretical education - 129 credits, professional practice - 11 credits, physical training - 8 credits and final attestation - 3 credits.

Awarded degree with full development of the educational program - Bachelor of Engineering and Technology in the specialty "5B071600 - Instrument making".

5. Code and name of the specialty

The code of the specialty "5B071600 - Instrument Making", in accordance with the Classifier of specialties of higher and postgraduate education of the Republic of Kazakhstan, this educational program belongs to the section of engineering and technology.

In the National Classifier of the Republic of Kazakhstan (NC RK 01-2017 Classification of Occupations), engineers have the code 2149, 2152 and belong to specialists-professionals in the field of engineering and electrical engineering.

6. Level of qualification according to the International Standard Classification of Education

This educational program corresponds to the ISCED level 6, which does not require prior completion of other programs and is classified as a first-degree program. Direction of training - undergraduate. Duration of training - 4 years.

According to the International Standard Classification of Education (ISCED 2013), this educational program belongs to the following field of education:

4 Science	52 Engineering and engineering trades Engineering drawing, mechanics, metal work, electricity, electronics, telecommunications, energy and chemical engineering, vehicle maintenance, surveying.

7. Objectives of the educational program

– The educational program is focused on the training of highly qualified specialists in the field of engineering and technology with specific knowledge and competencies in demand in the labor market.

– The objectives of the educational program are:

– - formation of a national model of continuing education integrated into the world educational space by comparison with foreign educational programs that meets the needs of the individual and society in the specialty “5B071600 - Instrument Making”;

– - creating conditions for the development of creative potential, initiative and innovation;

– - obtaining knowledge of the fundamental disciplines of engineering and technology with the subsequent conscious choice of professional elective disciplines;

– - acquisition of practical skills required by the bachelor of engineering and technology in the specialty "5B071600 - Instrument Making " during the period of training and production practices;

– - formation of graduates' competitiveness in the labor market;

– - Acquisition of a complex of knowledge that forms the basis of this profession, skills and abilities to navigate in the flow of information and obtain new knowledge for continuing education in at master and PhD levels.

8. Field of professional activity of a specialist

The sphere of professional activity of the bachelor in the specialty "5B071600 - Instrument Making" is:

- enterprises and organizations of all industries;
- military-industrial industry;
- transport and communications;
- agriculture and utilities;
- medicine (nuclear medicine);
- education and consumption;
- design organizations;
- companies of various forms of ownership;
- in enterprises working with electronic instruments.

Types of economic activity in accordance with GCEA (General Classifier of Types of Economic Activity) in which this profession is in demand:

24460 Nuclear fuel processing;

26600 Manufacture of irradiation, electromedical and electrotherapeutic equipment;

27909 Manufacture of other electromechanisms and devices;

29310 Manufacture of electrical and electronic equipment for motor vehicles (without repair);

27511 Manufacture of household appliances, except refrigerators and freezers;

27901 Manufacture of electrode products;
26512 Manufacture of electrical measuring instruments;
27902 Manufacture of electrical insulation products;
27401 Production of light bulbs;
27110 Manufacture of electric motors, generators and transformers (without repair);
26110 Manufacture of electronic parts;
26120 Manufacture of electronic loading panels;
26400 Manufacture of electronic devices for users;
27330 Manufacture of electrical appliances;
27120 Manufacture of electrical distribution and control equipment (without repair);
27903 Production of electrical signaling equipment;
23191 Manufacture of electrotechnical and electrovacuum glass;
35113 Electric power generation by nuclear (atomic) power plants;
35130 Power Distribution;
95210 Repair of consumer electronics;
35113 Electric power generation by nuclear (atomic) power plants;
28993 Manufacture of special technological equipment for the electronics industry;
32502 Manufacture of medical instruments, apparatus and equipment;
71121 Engineering activities and the provision of technical advice in this area;
72190 Other research and development in the natural sciences and engineering;
74909 Other professional, scientific and technical activities that are not included in other categories;
62090 Other activities in the field of information technology and computer systems.

9. Directions of professional activity

Graduates in the specialty "5B071600 - Instrument Making" can perform the following types of professional activity:

production and technology

– development of technical specifications for the design of individual units of devices, accessories and special tools provided by the technology;

– organization of maintenance of technological equipment for the electronics industry;

– quality control of electronic measuring instruments;

organizational and managerial

– development of plans for design and technological work and monitoring of their implementation, including the provision of relevant services with the necessary technical documentation, materials and equipment;

– development of optimal solutions for the creation of instrument-making products, taking into account the requirements of quality, cost, execution time, competitiveness and life safety, as well as environmental safety;

– establishment of the order of execution of works and the organization of routes for the technological passage of the elements and assemblies of devices and systems in the process of their manufacture;

– monitoring the compliance of the developed projects and technical documentation with the standards, technical specifications and other regulatory documents;

settlement and design

– carrying out settlement and design work on the creation of industrial machinery and equipment;

– development of projects for the creation of electrical and electronic equipment for various industries and fields;

assembly and adjustment

– know the rules and methods of installation, adjustment and adjustment of nodes of devices and systems, including those related to the inclusion of a human operator in the control loop of devices;

– conduct calibration, adjustment and adjustment of equipment, setting up software tools used for the development, production and adjustment of instrumentation equipment;

service and operational

– practically apply the basic rules for the repair and maintenance of devices, the fundamentals of technology for servicing instrumentation;

– to own the means of operation of instrument databases, expert and monitoring systems;

– prepare applications for spare parts and consumables, as well as verification and calibration of equipment;

experimental research

– study of the physical and chemical properties of materials;

– analysis of physical processes and phenomena, the establishment of empirical dependencies and patterns;

– research of new materials and modern technologies;

– operational and manufacture

– drawing up a technical map of the technological process;

– organizing and conducting special technological observations;

– installation of industrial machinery and equipment;

expert

– critical control of standardization and certification of devices, devices and equipments;

– examination of new materials;

– consulting on the technological state of devices, devices and equipments;

– providing technical advice on the characteristics of devices, devices and equipment;

– participation in the technological examination of projects;

project (survey)

– technological substantiation of the projected processes;

– assessment of the impact of technological factors on the state of the environment and the development of recommendations for their accounting in order to protect the air basin;

– participation in the assessment of the status of instruments, devices and equipments;

educational (pedagogical)

– teaching technical, circuitry and electrotechnical disciplines in secondary and secondary vocational schools;

– teaching and auxiliary work in universities.

10. Competencies of the specialist

Instrument making engineer must have general cultural (CC) and professional (PC) competencies, including:

Competence Code	Competency description
CC-1	to formulate the main stages of the modern history of the progressive development of the statehood of Kazakhstan, in the context of the world and Eurasian historical process
CC-2	to freely interpret and creatively use scientific, historical and philosophical knowledge to summarize the success factors of the Kazakhstan development model on the way to an established state - the Republic of Kazakhstan
CC-3	to demonstrate competent use of linguistic and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena
CC-4	to represent social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions
CC-5	to describe the basic laws of the functioning and development of nature and society
CC-6	to search and use of information necessary for the effective performance of professional tasks, professional and personal development
CC-7	to work in a team, communicate effectively with colleagues, management
CC-8	to demonstrate critical thinking when working with new information

CC-9	to be able to communicate in oral and written forms in Russian and foreign languages to solve problems of interpersonal and intercultural interaction
CC-10	to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies
PC-1	to present the scientific picture of the world, adequate to the modern level of knowledge, on the basis of knowledge of the basic provisions, laws and methods of the natural sciences and mathematics
PC-2	to reveal the natural-scientific essence of the problems arising in the course of professional activity, to involve the physics and mathematics apparatus for their solution
PC-3	to take into account modern trends in the development of technology in professional activities
PC-4	to process and present experimental data
PC-5	to organize and conduct special technical experiments
PC-6	to collect, process, analyze and systematize scientific and technical information on the subject of research
PC-7	to use modern software for the preparation of design and technological documentation
PC-8	to be able to use the methods of information technology, comply with the basic requirements of information security, including the protection of state secrets
PC-9	to develop plans for design and technological work and control of their implementation, including the provision of relevant services with the necessary technical documentation, materials and equipment
PC-10	to formulate the physical processes occurring in real systems
PC-11	to explain the nature of the occurrence of various optical and electrical phenomena in the atmosphere
PC-12	to be able to demonstrate acquired knowledge in the field of designing instruments and control devices
PC-13	to demonstrate an understanding of the paradigms, the overall structure and key elements of the technology for designing devices and systems, and its relationship with other disciplines
PC-14	to analyze a complex research situation and propose solutions using available tools, and methods
PC-15	to apply various methods and tools, such as computational physics, numerical modeling, mathematical analysis, visualization tools, etc. to solve a wide range of problems of scientific and practical interest
PC-16	to demonstrate the acquired knowledge of methods and tools of medical physics and visualization tools
PC-17	to apply methods of computational physics, such as numerical modeling, mathematical analysis, visualization tools, etc. for various fields of nuclear physics and computed tomography in particular

PC-18	to demonstrate acquired knowledge of programming languages and simulation at various levels of professional competence
PC-19	to apply the methods of mathematical computer simulation of automatic control systems
PC-20	to know the principles of functioning of automatic control and management systems and the most common technical means to ensure such control
PC-21	to use modern databases and information retrieval methods
PC-22	to independently acquire and use new knowledge and skills

11. Learning outcomes oriented to Dublin descriptors

Upon completion of this educational program, students are expected to be able to:

Cognitive competencies:

A1. explain the basic laws of the functioning and development of nature and society, be able to adequately navigate in various socio-economic, political and emergency situations; freely interpret and creatively use scientific, historical and philosophical knowledge to summarize the success factors of the Kazakhstan development model on the way to an established state - the Republic of Kazakhstan;

A2. describe the basic laws of the functioning and development of nature and society; to adequately navigate in various socio-economic, political and emergency situations; make decisions in standard and non-standard situations and take responsibility for them;

A3. present the scientific picture of the world, adequate to the modern level of knowledge, on the basis of knowledge of the basic provisions, laws and methods of the natural sciences and mathematics;

Functional competencies:

B1. create projects and develop plans for engineering and technological work and monitor their implementation, including providing relevant services with the necessary technical documentation, materials, equipment;

B2. apply various methods and tools, such as computational physics, numerical modeling, mathematical analysis, visualization tools, etc. to solve a wide range of problems of scientific and practical interest;

B3. work on modern software for the preparation of design and technological documentation;

B4. analyze a complex research situation and propose solutions using available tools and methods;

B5. reveal the natural and scientific essence of the problems arising in the course of professional activity, involve the physics mathematics apparatus for their solution; evaluate the principles of functioning of automatic control and management systems and the most common technical means for ensuring such control;

B6. use modern databases and information retrieval methods; be guided in the conditions of technology change in professional activity.

Systematic competencies:

C1. explain the features of modern trends in the development of technology in their professional activities;

C2. formulate calculations of production standards, technological standards for the consumption of materials, workpieces, tools, the choice of standard equipment, a preliminary assessment of the economic efficiency of technical processes;

C3. develop optimal solutions for the creation of instrument-making products, taking into account the requirements of quality, cost, execution time, competitiveness and life safety, as well as environmental safety;

Social (communicative) competence:

D1. competently use linguistic and cultural-linguistic knowledge to solve communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; percept, analyze, synthesize information, set goals and choose ways to achieve it.

12. The correlation of the expected learning outcomes of the program on the learning and evaluation tools in the formation of competence

The cipher and name of competence	Expected results (components of competence)	Modules, practice
CC-1 The graduate has knowledge of the basic stages of the recent history of progressive development of statehood of Kazakhstan, in the context of the world and Eurasian historical process; able to interpret and creatively use a scientific-historical, economical and philosophical knowledge to summarize the success factors of Kazakhstan's model of development on the way to held the state – the Republic of Kazakhstan; CC-2 The graduate is able to work autonomously, taking initiatives and managing time; is able to organize complex efforts over a period of time, producing the required result on schedule; has critical and self-critical abilities; is able to think in scientific terms, propose problems, gather data, analyse them and propose findings; CC-3 The graduate has communication skills (readiness for effective oral and written communication in the course of their professional activities in English; ability to write and speak correctly according to the various communication registers: scientific, formal, informal); CC-4 The graduate keep science and engineering ethics	Demonstrate the main stages of the modern history of the progressive development of the statehood of Kazakhstan (1991-2014) In the context of world and Eurasian history. Interpret and creatively use scientific, historical and philosophical knowledge to summarize the success factors of the Kazakhstan development model on the way to the statehood of the Republic of Kazakhstan. Competently use language and linguistic and cultural knowledge to solve communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena. Apply automated data processing; explain the purpose, composition, basic characteristics of computer and office equipment, the main methods and means of processing, storing, transmitting and storing information, goals and principles of using application and system software; technological search of information on the Internet, key threats and methods of information security, principles of protecting information from unauthorized access, the legal aspects of the use of information technology and software. Identify major trends in information communications technology; know which economic and political factors contribute to the development of information	**1. GENERAL EDUCATION Compulsory Component** **(21 credits)**

(readiness for conducting scientific and engineering activities in compliance with the general culture of ethics and professional ethics); CC-5 The graduate comply laws and regulations (the willingness to comply with all legal standards and requirements, including those related to health and safety compliance in the management of scientific and engineering activities); CC-6 The graduate has willingness to cooperate with colleagues and to work in a team, and is able to work with others in a multidisciplinary multi-national setting; CC-7 The graduate is social responsible (adoption of the common good as a top priority of scientific and engineering activity, readiness to bear responsibility for the social, cultural and environmental implications of the complex scientific and engineering activities in the context of sustainable development); PC-3 The graduate knows the principles of safety engineering, is ready for estimation of nuclear and radiation safety, to environmental impact assessment, to monitor compliance with environmental safety, safety standards and rules of industrial sanitation, fire, radiation and nuclear safety, labour standards. PC-4 The graduate is able to use scientific and technical information, national and international experience on the subject of the study, modern computer technology and databases in their area;	communication technologies; architectures to be able to calculate and evaluate the performance of supercomputers; features of various operating systems. In modern conditions, apply the study of the history of the state and law, based on experience and knowledge, in order to recreate an objective picture of the history of the state and the law of the country. Express your thoughts and speak in a foreign language and, respectively, the standards of the spoken language, ask questions and answer them, conduct a conversation in a foreign language in terms of the volume of the subjects being studied, using adequate communication signals to convey the content, read, heard. Develop and defend their scientific position; solve theoretical and methodological issues in the field of science. Use information resources to search and store information; apply methods and means of information protection; design and create simple websites; process vector and raster images; use various forms of e-learning to enhance professional knowledge; use various cloud services.	

understands the nature and significance of information in the development of modern informational society; is aware of the dangers and threats that arise in the process to comply with the basic requirements of information security, including protection of state secrets.		
CC-3 The graduate has communication skills (readiness for effective oral and written communication in the course of their professional activities in English; ability to write and speak correctly according to the various communication registers: scientific, formal, informal); PC-1 The graduates have sound knowledge of the university level mathematics and physics, required for understanding various processes and phenomena in nature and technics; are able to use the advanced laws and principles of physics in professional activities, applying methods of mathematical analysis and modelling, theoretical and experimental physics. PC-2 The graduates have an extensive understanding of the fundamental principles of physics, their inherent relation and mathematical formulation and, based on this, have acquired methods suitable for theoretical analysis, modelling and simulation of relevant processes; are familiar with important mathematical methods used in physics and can use these to solve standard physics problems, understand advanced laws of interaction between the matter and nuclear	Confidently know the structure of the space of real numbers, the convergence of numerical sequences, understanding the criteria of convergence. Learn the basics of the methods of researching the properties of functions, clearly understand the concepts of the concept of continuity of functions, their differentiability, integrability. To know the basic mathematical concepts involved in the program, their interrelation, interdependence and interaction not only among themselves, but also with other mathematical disciplines. Explain the power and energy characteristics of the electrostatic field, know the relationship between them; the principle of superposition; voltage vector flow; Gauss theorem; electric power; current density and current strength; resistance, voltage, electromotive force; laws of direct current; magnetic field induction; flux vector magnetic induction. Successfully apply the circulation theorem; Ampere's law and Lorentz force. Know the physical interpretation of inductance; electromagnetic induction law. Apply the theory of a harmonic oscillator and related concepts (frequency, phase, amplitude,	**2. BASIC DISCIPLINES** **Compulsory Component** **(20 credits)**

radiations, radiation protection principles and safety regulations; are able to apply this knowledge in practice in real laboratory conditions. PC-8 The graduates must stage, test and analyses standard scientific, engineering, pedagogical problems to evaluate and select the necessary information; apply the necessary theoretical and practical methods for the analysis of standard problems in the field of activities. The have applied their knowledge to physics problems in an exemplary manner and studied nuclear and particle physics areas in greater depth, thereby acquiring a first basis for problem solving competence. PC-9 The graduate understands the ideology of search and innovation (knowledge of constantly ongoing technological changes, economic situations, modern industrial and environmental trends and issues, and ability to generate creative solutions in the field of activity). PC-10 The graduate is able to continue his education throughout life (continuous readiness for further training and professional development, adequate for the maintenance and development of competences).	energy); the relationship between amplitude, frequency and energy of a harmonic oscillator. Apply modern vocabulary and terminology in Kazakh (Russian) and English for technology and project management methodology, project management processes, modern project management software. In the process of training, future specialists will learn the basics of the theory of conversion and production of signals, the most important electrical quantities, units of measurement, transformations, calculation and modification of various components of electronic devices. In the process of training, future specialists will master the basic ray tracing; imaging systems; advanced ray tracing: Hamiltonian optics; optical system design; scalar linear wave propagation; wave properties of light and polarization. Master at a high level the necessary information for the intensification of production processes, the construction of fully automated production facilities. Correctly apply the basic methods of mathematical analysis to solve various mathematical problems; acquire practical skills for solving problems, correctly choose a method for solving problems and solve them; put into practice the differentiability and integrability of numerical methods. Know the specific conditions of convergence of numerical methods. Acquire practical skills in applying differential and integral calculus in problems of mechanics and physics. Accurately and thoroughly substantiate the reasoning,	

	without cluttering it with unnecessary details. Find characteristics of electric, magnetic (in vacuum and matter) and gravitational fields and thermal equilibrium radiation using Maxwell's equations and elements of field theory (vector and scalar fields). Find forces acting on the charged particles in the electric and magnetic fields, as well as their combined effect on the conductors with a current in a magnetic field. Determine main parameters of electric currents in vacuum, gases, plasma. Find main characteristics of free harmonic, damped, as well as forced oscillations and resonance, which includes elements of the theory of functions of a complex variable and differential equations. Find energy, amplitude and speed of wave propagation. Be able to implement systematic theoretical and basic knowledge in various educational spaces, use practical skills to set simple research tasks, own a professional speech culture. Master the basic principles of construction and operation of electronic devices, use the achievements of electronics in various fields of professional activity. Understand the theory of interference and the use of interferometers. Describe spatial filtering, coherent and incoherent imaging. Explain wavefront modulation, holography, diffraction optics, subwave optics: “nanophotonics”, “metamaterials”. In the process of training, future specialists will learn the basics of the theory of electrical circuits, the most	

	important electrical quantities, units of measurement, the production and transmission of electrical energy, the transformation, calculation and modification of various power devices.	
CC-2 The graduate is able to work autonomously, taking initiatives and managing time; is able to organize complex efforts over a period of time, producing the required result on schedule; has critical and self-critical abilities; is able to think in scientific terms, propose problems, gather data, analyse them and propose findings; CC-3 The graduate has communication skills (readiness for effective oral and written communication in the course of their professional activities in English; ability to write and speak correctly according to the various communication registers: scientific, formal, informal); CC-4 The graduate keep science and engineering ethics (readiness for conducting scientific and engineering activities in compliance with the general culture of ethics and professional ethics); CC-6 The graduate has willingness to cooperate with colleagues and to work in a team, able to work with others in a multidisciplinary multi-national setting; CC-7 The graduate is social responsible (adoption of the common good as a top priority of scientific and engineering activity, readiness to bear responsibility for the social, cultural and environmental implications of the complex scientific and engineering activities in the	Understand and put into practice: the structure and operation of microprocessors; technology of integration and technological condition of microprocessor structure properties. Interpret progress, trends and microprocessors review. Describe the structure and operating systems of microprocessors; technology, parameters and operation of memories; input / output systems; programming and activation of the development of microprocessor systems. Analyze the basics of development and creation of information and measurement systems, such as technical systems and functioning basic information and measurement systems, as hardware and software. Classify measurements, showing the characteristic specific features and features of the methods and the validity of the measurement processes. Apply major models of FPGA. Use the software environment. Design various digital electronic circuits. Use devices for programming logic integrated circuits. Solve problems by applying the features of FPGA. Use circuits with different characteristics. Use real measurement hardware and software. Apply virtual information and measuring systems using modern information and modeling technologies of various types, including computer, mathematical, physical, with	**3. MAJORS Compulsory Component** **(5 credits)**

context of sustainable development); PC-4 The graduate is able to use scientific and technical information, national and international experience on the subject of the study, modern computer technology and databases in their area, understand the nature and significance of information in the development of modern informational society, aware of the dangers and threats that arise in the process, to comply with the basic requirements of information security, including protection of state secrets.	extensive use of computer, which helps to conduct experimental measurements.	
CC-2 The graduate is able to work autonomously, taking initiatives and managing time; is able to organize complex efforts over a period of time, producing the required result on schedule; has critical and self-critical abilities; is able to think in scientific terms, propose problems, gather data, analyse them and propose findings. PC-1 The graduates have sound knowledge of the university level mathematics and physics, required for understanding various processes and phenomena in nature and technics; are able to use the advanced laws and principles of physics in professional activities, applying methods of mathematical analysis and modelling, theoretical and experimental physics. PC-3 The graduate knows the principles of safety engineering, is ready for estimation of nuclear and	At a professional level, know structured programming. Analyze and develop algorithms. Master the syntax and semantics of C; logical and syntax debugging; basics of software development. Apply the theory of algebraic equations, the basic properties of determinants and matrices, an algebraic and geometric description of lines and surfaces of second order, introductory information about groups, rings and fields. Apply basic mathematical concepts and fundamentals of vector algebra to teach general physics courses, such as mechanics or molecular physics. Interpret basic mechanical models and phenomena; mechanical laws and concepts, the limits of their applicability, allowing them to be effectively used in specific situations. Understand the main technospheric and artificial hazards,	**4. GENERAL EDUCATION Elective Course** **(8 credits GE)**

radiation safety, to environmental impact assessment, to monitor compliance with environmental safety, safety standards and rules of industrial sanitation, fire, radiation and nuclear safety, labour standards. PC-5 Should be able to demonstrate the acquired knowledge of the programming languages. PC-7 Analyze complex situation and offer solutions to its challenges using computational tools provided by the course. PC-6 Graduates are able to calculate, design and construct in accordance with the specifications of systems, instruments, parts and components at the circuit and element levels using standard computer-aided design tools; carry out design calculations and preliminary feasibility studies of projects. PC-7 Graduates are capable ofsetup, configuration, alignment and experimental verification of instruments and systems used in experimental nuclear physics and nuclear medicine. PC-8 Graduates are able to reveal the natural-science essence of the problems arising in the course of professional activity, to involve the physics and mathematics apparatus for their solution PC-10 The graduate is able to continue his education throughout life (continuous readiness for further training and professional development, adequate for the maintenance and development of competences).	their properties and characteristics, the nature of the impact of harmful and dangerous factors of production on humans and the environment, methods of protection against them; legislation and legal acts in the field of life safety, methods and technologies of protection in emergency situations; future specialists will acquire the theoretical knowledge and practical skills necessary to create safe and harmless living conditions; identify the main hazards of the human environment, assess the risk of their implementation. Use elementary methods using arithmetic operators and mathematical expressions in C ++ programming. Choose the appropriate data type to represent the data. Write C ++ programs that use choices (if, switch, conditional statement). Write C ++ programs that use loops (while, dowhile, for). Write C ++ programs that use sequential files for input and output. Write C ++ programs that use functions to transfer control. Write C ++ programs that use arrays, including sorting and searching for arrays. Write C ++ programs that use pointers. Solve programming problems with C ++. Understand how to accurately and carefully state the essence of a particular problem without cluttering it with unnecessary details. Get an idea of how to solve problems of mathematical analysis, algebra and analytical geometry. Acquire practical skills to solve problems, to use a	

	specific mathematical method to reduce the problem to its simplest expression and choose the way to solve it. Continue education with a high degree of autonomy. Apply modern mathematical tools to solve and analyze problems of mechanics, physics and the natural sciences. Interpret the content of the discipline, including new knowledge. Analyze educational problems and suggest ways to solve them. Apply the methods (research, calculation, analysis, etc.) inherent in the field of analytical geometry. Synthesize, interpret and evaluate the learning outcomes of analytic geometry, modules, intermediate exam level. Understand the modern concepts of natural and man-made processes that cause a violation of safety requirements for life, environmental protection, make decisions in emergency situations and protection. Apply monitoring and measurement methods in the field of safety and environmental protection. To possess methods and technologies of protection in emergency situations. Use knowledge about the organization of security in emergency situations at the facilities of the economy, in everyday life, in the environment.	
CC-2. The graduate is able to: work autonomously, taking initiatives and managing time; able to organize complex efforts over a period of time, producing the required result on schedule; has critical and self-critical abilities to: able to think in scientific terms, propose problems, gather data, analyse them and propose	Apply basic concepts and laws in mechanics; kinematic equations; Newton's laws of dynamics; free body diagrams; conservation laws for determining the movement of physical bodies; basic concepts and laws in thermodynamics; basic concepts and laws in the phenomena of transference.	**4.BASIC DISCIPLINES Elective Course (49 credits)**

findings. CC-3 The graduate has: communication skills (readiness for effective oral and written communication in the course of their professional activities in English; ability to write and speak correctly according to the various communication registers: scientific, formal, informal)/ CC-4 Ethics engineering (readiness for conducting engineering activities in compliance with the general culture of ethics and professional ethics Engineer Code). The graduate keeps science and engineering ethics (readiness for conducting scientific and engineering activities in compliance with the general culture of ethics and professional ethics). CC-7 Social responsibility (adoption of the common good as a top priority of engineering activity, readiness to bear responsibility for the social, cultural and environmental implications of the complex engineering activities in the context of sustainable development). PC-1 Should be able to demonstrate the acquired knowledge of the programming languages. The graduates have sound knowledge of the university level mathematics and physics, required for understanding various processes and phenomena in nature and technics; are able to use the advanced laws and principles of physics in professional activities, applying methods of mathematical analysis and modelling, theoretical and experimental physics.	Interpret the main laws, concepts and theories of chemistry and its understanding; physical and chemical properties of elements; elements of the periodic system of Mendeleev and its understanding. Understand the concept of a good quantum number and simultaneous observability. Understand quantum numbers, including their physical significance, and the quantum mechanical states of the hydrogen atom. Understand the origin of the width and shape of lines in atomic spectra. Know about the origin of the fine structure in atomic spectra. Understand the exchange degeneracy and how it affects the excited states of helium. Understand the conclusion and the possibility of applying the selection rules for the interaction of electric dipole radiation and atoms. Know about Einstein's A and B coefficients and their relationships. Understand modern programming languages, experimental data processing and numerical simulation of a physical experiment, including Matalb, C ++, Microsoft Visual Studio and others. Knowledge of programming languages includes algorithms, variables, and basic structures; C ++ variable types basic arithmetic operations. Use numerical methods to solve ordinary differential equations, including the differential equations of motion of Newton. Solve problems of a body thrown at an angle to	

PC-2 Demonstrate an understanding of the overall structure and key elements of the computational physics course and their relationship to the nuclear physics. The graduates have an extensive understanding of the fundamental principles of physics, their inherent relation and mathematical formulation and, based on this, have acquired methods suitable for theoretical analysis, modelling and simulation of relevant processes; are familiar with important mathematical methods used in nuclear physics and can use these to solve standard nuclear physics problems, understand advanced laws of interaction between the matter and nuclear radiations, radiation protection principles and safety regulations; are able to apply this knowledge in practice in real laboratory conditions. PC-3 Graduates are able to reveal the natural-science essence of the problems arising in the course of professional activity, to involve the physics and mathematics apparatus for their solution. Student should be able to include the new acquired information into the context of the nuclear physics knowledge and reinterpret its contents numerically. PC-4 Graduates are able to take into account current trends in the development of technology in their professional activities. Analyze complex situation and offer solutions to its challenges using computational tools provided by the course. The graduate is able to use scientific and technical information, national and	the horizon and rebounding from perpendicular to the movement of the walls; the problem of a ball rolling down a rigid ladder, etc. Understand and apply the Verlet algorithm and its variations. Numerically interpret the conservation laws in Newton's dynamics for the purpose of computer simulation. Must know the method of application of the iteration of the Picard process, the modified Euler method, the predictor-corrector method; frog jump method and Euler-Cromer algorithm for solving an ODE. Have working knowledge of data formatting procedures and their recording in a file for further processing and visualization. Apply elements of the theory of the numerical solution of nonlinear differential equations; stability of the numerical solution. Distinguish between types of equations of the order above the first, which can be reduced to a system of differential equations7 Use numerical integration, including trapezoidal formulas, rectangle formulas, Simpson's rule, etc. Know the methodologies of applying numerical methods for modeling the motion of charged particles in electric and magnetic fields, computer models of Kepler's laws, rotation and rotational motion, Rutherford scattering, Coulomb interaction between two free charges. Working knowledge of the use and construction of Newton and Lagrange interpolation polynomials. Must know Fourier series; Fourier transform; Fourier	

international experience on the subject of the study, modern computer technology and databases in their area, understands the nature and significance of information in the development of modern informational society, aware of the dangers and threats that arise in the process, to comply with the basic requirements of information security, including protection of state secrets. PC-5 Graduates are able to collect, process, analyze and systematize scientific and technical information on the subject of research. Be able to apply the methods of computational physics such as numerical simulations, mathematical analysis, visualization tools etc to the diverse fields of nuclear physics. The graduate is able to use the standard mathematical and numerical methods to carry out mathematical modelling of processes and objects on the basis of standard packages and computer-aided design studies; is able to use contemporary software, computer mathematics packages and programming languages for solving standard problems in the field of nuclear physics and nuclear engineering. PC-6 Graduates are able to use modern software for the preparation of design and technological documentation. The graduates are familiar with basic principles of experimentation; are able to use modern physics measurement methods; are in a position to assess the significance of results correctly; are ready to carry out physical experiments by given method, compiling	series of some special functions. Complex form of Fourier series. Own the theory of random numbers; pseudo-random number generators. Apply methods for the numerical solution of the Schrödinger equation using the variational method. Apply probability theory and its understanding (random event, definition of probability, basic probability formulas, independent research, random variables, etc.). Formation of students' knowledge of the principles of action, parameters and features of the main classes of modern semiconductor devices and integrated circuits and operating modes; Formation of students' knowledge of the basic principles of analog electronic devices (AEU) circuit technology and methods for their analysis. Must know the principles of action and feedback, i.e. response, construction methods and the study of various systems and individual technical tools and automation methods. By this is meant: Knowledge of impulse devices; parameters and features of pulse and variable signals; linear elements for impulse devices; RC and RL circuits; switches based on transistors. Understand how switches work; symmetric and asymmetric triggers. Apply basic trigger schemes, as well as blocking generators; linear voltage alternator; linear voltage generator Demonstrate the mode of operation of the comparator. Use discriminators to analyze pulse signals. Master the basic principles of discrete automation. Boolean and other	

descriptions of ongoing research and analysis of results; are able to use technical means to measure the main parameters of objects of study, write a report on the job, to participate in the implementation of the results of research and development, prepare data for the compilation of reviews, reports and scientific publications. PC-7 Graduates are able to process and present results of experimental studies. PC-8 Graduates are able to own the rules and methods of installation, adjustment and adjustment of the nodes of devices and systems, including those related to the inclusion of a human operator in the control loop. The graduates must stage, test and analyse standard scientific, engineering, pedagogical problems to evaluate and select the necessary information; apply the necessary theoretical and practical methods for the analysis of standard problems in the field of activities. The have applied their knowledge to physics problems in an exemplary manner and studied nuclear and particle physics areas in greater depth, thereby acquiring a first basis for problem solving competence. PC-10 Graduates are able to make applications for spare parts and consumables, as well as verification and calibration of equipment. The graduate is able to continue his education throughout life (continuous readiness for further training and professional development, adequate for the maintenance and development of competences).	logical functions. Truth tables for Boolean Laws and their statements. Apply gates on MOS transistors, design complex logic gates and devices, and also synthesize combined devices on logic elements. Demonstrate the synthesis of incompletely defined logical functions and logic devices with multiple outputs. Explain the characteristics of digital devices; calculus systems; performing arithmetic operations; integrated logic circuit. Apply encoders, decoders, code converters; multiplexors and demultiplexes; programmable logic array of elements. Demonstrate the operation of addressable registers, electronic meters and adders and their application; analog-to-digital converters; electronic valves for storing information and schemes for their implementation. Apply digital circuit control devices; digital schematics of control devices of the circuit and software design. To understand the basic architecture and principles of action; linear and parallel computing paradigms; CPUs and their architecture; input - output and device interfaces; external storage devices; microcontrollers and programmable microcontrollers. Demonstrate knowledge of the theory of the structure of the atomic nucleus. Apply types and patterns of radioactive decay; effective cross sections and methods for their measurement; the laws of the passage of radiation through matter; mechanisms of nuclear reactions and their types; the physical basis for using the properties	

	of nuclei and nuclear radiation in science and technology; basic laws of fission and nuclear fusion. Interpret theoretical and practical information about the basic principles of FPGA programming and task options for the main sections of programming and construction, as well as tasks that require logical reflection for students in the performance of laboratory and independent work. Understand the nature and features of the measurement process. To master the methods of temperature measurement: thermoelectric and thermoresistive; temperature measurement by thermomagnetic method; temperature measurement by pyrometric methods. Apply measuring and control devices; generalized block diagram of measuring and control devices; metrological characteristics of measuring and control devices. Explain the classification of physical quantities; absolute and relative measurement errors; weight tools. Use measuring and control devices with mechanical, optical, optical-mechanical, pneumatic and radioactive transducers. Master the methods of measuring and controlling thermal values. Apply methods and means of measuring and controlling temperature; methods of measurement and control of electrical and magnetic quantities; means and units of measurement. Interpret the theory of measurement of optical radiation. Master the basic concepts of measurement theories. Master the methods of measuring acoustic values; measurement of pressure, quantity and flow of gases and	

	liquids. Describe test methods for measuring and controlling instruments. Understand the basic concepts of dosimetry and radioactive sources. To establish the connection of the nuclear-physical mechanisms of interaction of ionizing radiation with biological matter. Understand the laws, patterns, systematics, effects and phenomena in the field of applied science on the creation of the core of nuclear reactors; in the field of science - concrete examples of the introduction of powerful nuclear power plants. Assess the main regulatory framework for nuclear energy and radiation safety of the population of the Republic of Kazakhstan. Determine the basic principles of radioactive waste storage. Apply basic sanitary and epidemiological standards for radiation safety for both staff and the public. Practice evidence-based workplace organization methods in accordance with general and special precautionary regulations. Experimentally determine alpha, beta and gamma background both indoors and in an open atmosphere. To be able to localize and eliminate the consequences of radiation accidents at various levels. To understand the objective laws of physical processes on a microscale scale; methods for recording ionizing radiation. Demonstrate methods and means of measuring and quantifying radiation. Apply the main types of interaction of neutrons and materials, their characteristics, methods of observation	

	and experimental research. Explain statistical distributions, their concepts and applications. Apply histogram basics, maximum similarity method, chi-square distribution, fitting (fitting), frequent and Bayesian approaches, basics of the ROOT structure. Understand different approaches to fitting, installation with a ROOT card. Understand the meaning of quality reduction, the basics of multidimensional analysis, data storage with the help of ROOT. Classify types (such as gas-filled detectors: simple ionization chambers, proportional, Geiger-Muller counters, semiconductor detectors: pn-junction, lithium drift, high-purity germanium, scintillation detectors: NaI (Tl), organic) and characteristics of detectors for high-energy radiations they work, and how they are used. Use electronic systems to detect and measure radiation. Explain the characteristics and use of nuclear detectors and the calculation of their properties (efficiency, energy resolution, temporal resolution, resolution of a pair of pulses, dead time). Compare the properties of different detectors and select the detector that is most suitable for this application. Describe qualitatively and quantitatively the result of measuring a certain radiation using a specific radiation detection system. Understand the basic concepts and mechanisms of interaction of radiation with matter. To determine the processes occurring during the interaction of accelerated charged particles, neutrons and gamma quanta with atoms and nuclei of atoms of matter.	

	Acquire scientific skills and conduct independent research work (thesis) in the field of nuclear physics and elementary particles. Understand the basic concepts of the laws of the flow of physical processes in major nuclear physics research and power plants. To keep abreast of current issues and unresolved issues of nuclear physics and technology. Understand the general laws of radioactivity in the natural environment and the theory of radiation sources. Apply methods and means of measuring and quantifying them. Summarize the results of applying the methods for calculating the modulusless nuclear parameters and the energy characteristics of the reaction nuclei and nuclear fuel. Familiarize yourself with the methodology, general principles and methods of mathematical physics. To possess highly specialized advanced theoretical knowledge and practical skills that are the basis for research and an original approach to solving professional problems. Understand the methodology and methods of empirical treatment (research) of the material and be able to use them in scientific and practical activities. Classify the architecture and command systems of microprocessors, principles of organization of microprocessor systems, as well as types of development of microprocessor technology based on microcontrollers. Apply modern methods of developing modern microprocessor technology by selecting microcontrollers	

	(microprocessors) and programming microprocessor devices using appropriate software and tool environments. Evaluate the results of the use of microcontroller programming methods and the development of specific microprocessor technology based on them. Understand the basic concepts and concepts of graphical programming in LabVIEW. Demonstrate the basics of programming in the LabVIEW environment and options for tasks for the main sections of programming and design, as well as tasks that require logical thinking for students to perform laboratory and homework. Understand the concepts and basic functions of graphical programming in LabVIEW, as well as be able to apply the knowledge gained in solving various physical and technical problems. Apply the basic methods and applications of nuclear spectrometry of gamma radiation, light and heavy charged particles, as well as neutrons. Understand the properties and characteristics of ionizing radiation, the main processes of interaction of charged particles, neutrons and photons with the matter of the detectors, the properties and characteristics of gamma radiation from sources of radionuclides. Use physical methods of radiation detection, methods for processing experimental data, evaluating experimental errors and calculating specific loads, methods for conducting radiometric and spectrometric measurements, modern methods of using information and communication technologies in a chosen field of activity. Analyze modern methods of designing and manufacturing	

	devices and devices. Apply the Matlab integrated development environment. Understand the main variables and structures, definitions, accuracy and their use, basic operations and operators. Analyze the results of the implementation of ODE solutions in Matlab and the Picard iteration process. Demonstrate the stability and convergence of the modified Euler method and the Euler-Cromer algorithm. Distinguish scalars, vectors, matrices, and multidimensional arrays in Matlab. Evaluate memory usage and allocation. Analyze the predictor-corrector method and the Leap-frog method of graphical implementation, 2D and 3D graphics. To distinguish nonlinear differential equations, to determine the stability of a numerical solution. Evaluate boundary conditions from graphics. Understand the loops in Matlab. Use cycles to calculate the sums and products of numerical series. Use custom functions to calculate factorial, polynomial and other special functions. Apply the fourth order Runge Kutta method. Calculate RLC circuits, charge and voltage diagrams. Describe Rutherford scattering in a laboratory system. Check the limit model of a noninteracting particle beam. Interpret the Coulomb interaction between two free charges and the scattering of a noninteracting particle beam by a massive charge. Apply methods for modeling the interaction between several particles in a closed space and periodic boundary conditions. Describe the ideal gas in three-dimensional space.	

	Apply Fourier spatial filters, low and high pass filters. Understand random numbers, pseudo-random number generators. Demonstrate estimates of areas by the Monte Carlo method and numerical calculation of multidimensional integrals. Solve the classical differential equations. Transform the physical situation, formulated in English, into a mathematical formulation. Apply basic mathematical tools, including vectors and calculus, to solve physical problems. Make use of physical intuition, including the ability to guess an approximate or conceptual response to a physical problem. Analyze the result of the calculation. Apply physical knowledge to other disciplines, including physics and engineering. To illustrate how physical observation, experiment, and theory worked together to develop inventions that advanced our civilization. Solve practical problems of chemistry. Offer optimal reaction conditions. Writing a scheme about converting chemicals from each other. Demonstrate acquired theoretical knowledge when passing intermediate and final exams. Experimenting reactions in the laboratory during laboratory classes and the use of various laboratory equipment and facilities. Analyze the results of educational activities of chemistry, their synthesis through scientific essays, presentations, etc. Understand and be able to apply time-dependent	

	perturbation theory to simple cases. Understand the periodic table in terms of electronic structure. Understand time-independent perturbation theory, including its derivation, and be able to apply it to simple systems, including the Stark and Zeeman effects. To be able to solve problems in atomic physics. To have the skills of scientific programming, to interpret and evaluate the results of training during the course of listening to the course and its individual modules, to be confident in passing the intermediate and final exams; Perceive in dynamics the process of numerical solution of scientific problems and predict its result; Compile a complete and competent quantitative analysis of the results of his study for the course, summarize its main ideas through scientific essays, scientific programming and writing code, etc. Have the skills to participate in educational and social interaction within the group and the educational environment created for this course; Have the skills of accepting and analyzing the task, perceive its importance and anticipate a numerical decision, accept criticism and be able to criticize, work in a team. The ability to recognize the important integral role of the course being listened to in the implementation of an individual learning path. Demonstrate an understanding of the general structure of probability theory and the relationship between its	

	elements, including new knowledge in the context of basic knowledge, and interpret its content. Analyze educational problems and suggest directions for their solution and methods of use (research, calculations, analysis, etc.) inherent in the field of probability theory for study individually or in a group, training and research activities. Synthesize, interpret and evaluate the results of the theory of probability, modules, average exam level. Analyze the dynamics of solving scientific problems of probability theory (scientific reviews of specific problem studies), as well as the skills of selecting and building AEU nodes. Explore measurement technologies that combine a combination of methods, approaches, software, and logical support for the organization of measurements; conditions and trends in the development of measuring instruments and basic methods for measuring the characteristics of electronic circuits and signals and assessing their accuracy. Analyze the automatic control system and select the main automation devices. To be able to see and implement, in theory and practice, the basic idea of automatic and automated control, types of automation systems, features and values of automation of agricultural production, synthesis of automatic control systems. Interpret and evaluate the results of the training activities of the course and its individual modules, to be sure, when faced with certain content of the mid-term and final exam. To be able to constructively participate in the educational	

	and social interaction in the group and the educational environment created for this course. Analyze a problem, feel its importance and foresee a numerical decision, take criticism and be able to criticize and work in a team.Use this knowledge in practice. Conduct assessments and engineering calculations of the results of nuclear transformations. Work with nuclear physics equipment. The main methods of nuclear physics research. Use sources and detectors of nuclear radiation. Understand the fundamental concepts and syntax of the Verilog programming language, theoretical and practical information about the basic principles of FPGA programming and task options for the main sections of programming and construction, as well as tasks that require logical reflection for students when performing laboratory and independent work. Develop and understand the concept and basic functionality of modern programmable logic integrated circuits, as well as the application of the knowledge gained, in solving various physical and technical problems. Understand the principles of the measurement process, the metrological characteristics and modes of operation of measuring devices, ensuring the uniformity of measurements, issues of potential measurement accuracy. Be able to optimize the measuring experiment in various measurement conditions and environmental effects; Perform operations with various types of measurement information.	

	Apply practical skills of general measurement theory to experimentally solve simple tasks.It is correct to choose measuring instruments in accordance with the required accuracy of the measurement result. Methodically correctly measure typical physical quantities and process measurement results. Apply fundamental knowledge of the laws of nuclear physics, in particular, in experimental and theoretical methods for calculating protection against ionizing radiation. Apply basic sanitary and epidemiological standards for radiation safety for both staff and the public. Practice evidence-based workplace organization methods in accordance with general and special precautionary regulations. Experimentally determine alpha, beta and gamma background both indoors and in an open atmosphere. Be able to localize and eliminate the consequences of radiation accidents at various levels. Demonstrate skills during presentations at scientific conferences and seminars on the physical understanding of the results obtained in the application of sanitary and epidemiological norms. Understand the differences between statistical distributions and the ability to apply a proper distribution. Fit models to observations using different methods: maximum probability, chi-square. Apply frequency and Bayesian approaches to testing hypotheses. Use ROOT structures for analyzing experimental data in	

	nuclear physics: fitting, multidimensional analysis, data storage and recovery. Independently understand the problems of modern nuclear radiation detection devices. Demonstrate ability and readiness. Use natural scientific knowledge in professional activities. Understand and establish professional tasks in research and practice. Apply advances in nuclear physics research in other areas of knowledge and, in particular, in radiation ecology. Use modern methods of processing experimental data, estimate errors in calculations and experiments. Use application packages for processing experimental data. Select and use recording equipment for conducting nuclear physics experiments and environmental monitoring. Selection, design and design of detectors for all types of emissions. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results. Demonstrate the ability to collect, analyze and systematize experimental and theoretical data. Propose methods of elementary systematics and to formulate the obtained laws.Independently understand the problems of modern nuclear radiation detection devices. Apply fundamental knowledge of the laws of quantum physics, in particular, in experimental and theoretical studies in the field of nuclear reaction and decay of radioactive nuclei, the laws of nuclear fission, nuclear thermonuclear physics and nuclear astrophysics. Use the	

	studied patterns to understand the physics of cosmic rays, nuclear decays in the Earth's lithosphere and the radiation processes occurring in living matter. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results obtained in the framework of the transition from classical physical to quantum concepts. To demonstrate the ability to collect, analyze and systematize the experimental and theoretical data on the spectra of nuclear radiation and their dependence on the structural characteristics of the nucleus. To propose methods of elementary systematics of the parameters of the nuclear structure and nuclear reactions and to formulate mathematically the obtained laws. Formulate the problem when working together in the framework of complex teams of experimental physicists and theoretical physicists, correctly formulate the goals and objectives of the study or practical application. Convince the audience of the need to use nuclear technology for practical purposes to justify their safety and reliability. Demonstrate skills in the study of new areas of the physics of the microworld. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results. Demonstrate the ability to collect, analyze and systematize experimental and theoretical data. To propose methods of elementary systematics and to formulate the obtained laws. Understand the architecture of microprocessors and	

	microcontrollers. Understand the principles of the organization of microprocessor technologies and modern methods of designing microprocessor technology. To put into practice the basic methods of programming microcontrollers. Develop hardware for digital devices. Designing various microprocessor based devices. Qualitatively select and use recording equipment for conducting experiments in nuclear physics and environmental monitoring. Qualitatively choose, make engineering calculations and design detectors of all types of emissions. Apply methods for processing experimental data, evaluating experimental errors and calculating the characteristics of radiation source fields. Solve the problems of nuclear spectroscopy. Have experience in the use of Internet resources in the course of research, including in a foreign language. Demonstrate acquired knowledge of programming languages and software development environments in professional activities. Demonstrate an understanding of the overall structure, procedures, and key elements of the modeling toolkit (IDE). To have the opportunity to incorporate new information obtained in the context of nuclear physics and high energy physics and to rethink its content on the basis of this information. Analyze the complex situation of designing and manufacturing devices and devices and propose solutions	

	to their problems; Apply methods and tools such as Matlab, Simulink, numerical modeling, mathematical analysis, visualization tools, etc. for various fields of nuclear physics and instrumentation.	
CC-1 Able to perceive the importance of computer assisted tomography methods in modern life and healthcare in particular. CC-2 The graduate is able to: work autonomously, taking initiatives and managing time; able to organize complex efforts over a period of time, producing the required result on schedule; has critical and self-critical abilities to: able to think in scientific terms, propose problems, gather data, analyse them and propose findings. Capable of incorporating the modern medical imaging tools and hardware in his life and experience. CC-3 The graduate has: communication skills (readiness for effective oral and written communication in the course of their professional activities in English; ability to write and speak correctly according to the various communication registers: scientific, formal, informal). Capable of communicating and interpreting information obtained through the usage of the computer assisted tomography and other apparatuses. CC-4 The graduate keeps science and engineering ethics (readiness for conducting scientific and engineering activities in compliance with the general culture of ethics and professional ethics). Actively involved in sharing and feeding back to the information	Solve the problem of processing analog and digital signals. Describe the characteristics and structure of the amplifiers. Distinguish classification and parameters of logical elements on integrated circuits. Use memory devices (triggers). Understand the characteristics and use of nuclear detectors and the calculation of their properties (efficiency, energy resolution, temporal resolution, resolution of a pair of pulses, dead time). Compare the properties of different detectors and select the detector that is most suitable for this application. Describe qualitatively and quantitatively the result of measuring a certain radiation using a specific radiation detection system. Understand the basic concepts of a modeling package in GEANT4, how to change input parameters. Simulate and learn how to work with the g ++ compiler (GNU c ++ compiler). Familiarize with basic bash commands. File Manager Midnight Commander Linux. Familiarize with the installation procedure of GEANT4 simulation package on Linux and Windows platforms. Familiarize with viewing VRML files with DeepExploration viewer. The principles of operation of individual detectors and the	**5. Individual educational trajectories (IET) (27 credits)**

and healthcare networks the previously collected medical data. CC-5 Able of mentoring to other colleges and contributing in continuing development of the human-computer coupled network and systems. PC-1 Student should be able to demonstrate the acquired knowledge of the medical imaging techniques. Student should be able to demonstrate the acquired knowledge of instrument making and control device design. PC-2 Demonstrate an understanding of the overall structure and key elements of the computer tomography course and its relationship to the nuclear physics. Demonstrate an understanding of the overall structure and key elements of the Technology of designing devices and systems course and its relationship to the other disciplines. PC-3 Include the new acquired information into the context of the nuclear physics knowledge and reinterpret its contents numerically and analytically. Include the new acquired information into the context of the instrument making and design required at the current level of the competence. Graduates know the principles of safety engineering; are ready to evaluate nuclear and radiation safety together with the environmental impact; and are able to monitor compliance with environmental safety standards and regulations of industrial sanitation, fire, radiation and	entire range of courses, all advanced global research, the natural scientific essence of problems arising in the course of professional activity, involve the physical and mathematical apparatus for solving them, technological processes of production, metrological guarantees and quality control of elements of devices for various purposes. The basic principles of programming Python. Understand the syntax of the language, features of Python and programming patterns. Use modern python libraries to analyze scientific data: numpy, scipy, matplotlib. Analyze the main scientific data: statistics, construction, installation. Conduct advanced data analysis of specific experiments. Demonstrate Python binding to C/C ++ languages. Work with a graphical user interface with Python and work with the HDF5 data format. Study and qualitatively accumulate knowledge about modern methods of designing and manufacturing devices and devices. Interpret the place of science and design methods in the life cycle of the measuring device. Apply block hierarchical approach, functional design of the measuring device. Principles of construction of devices and systems. Classify devices and systems. Develop a mathematical model of the measuring device, a mathematical model of the device for the static measurement mode, a mathematical model of the device for the dynamic measurement mode. Understand the static characteristics of the measuring device. Calculate the sensitivity coefficient of the measuring device, the error of the nonlinearity of the static	

nuclear safety, and labour standards. PC-4 Analyze complex situation and offer solutions to its challenges using computational tools provided by the course. Analyze complex real life situation and offer solutions to its challenges with available instrument design and production tools provided during the course. Graduates are able to use scientific and technical information, national and international experience, modern computer technology and databases in their areas of interest; understand the nature and significance of information in the development of modern society; are aware of the dangers and threats that arise in the information processing; and are able to comply with the basic requirements of information security, including protection of state secrets. PC-5 Be able to apply the methods of computational physics such as numerical simulations, mathematical analysis, visualization tools etc. to the diverse fields of nuclear physics and computerized tomography field in particular. Be able to apply the variety of methods and tools such as computational physics, AutoCAD such as numerical simulations, mathematical analysis, visualization tools etc. to the diverse range of problems of interest. Graduates are able to use the standard mathematical and numerical methods to carry out mathematical modelling of processes and objects on the basis of standard packages and computer-aided design software; are able to use contemporary software, computer mathematics packages and programming	characteristics of the measuring device. Distinguish dynamic and static characteristics of the measuring instrument/device, as well as characteristics of the measuring signals. Classify the types of dynamic characteristics of the measuring device, types of measuring signals, types of signal characteristics, characteristics of deterministic signals, energy and spectral characteristics. Analyze the calculated dynamic and static parameters, the accuracy of the measuring device. Equation of measurement error. Evaluate measurement errors at the design stage of a measuring device. Develop models of the measuring signal and calculate additive noise and total errors.Understand the basics of measuring instrument reliability. Classify the types of instrument performance. Organize research projects, design process, development work. Possess AutoCAD user interface, AutoCAD Cartesian workspace. Use commands to modify an existing drawing file. Select objects for editing, moving, copying, rotating, scaling, mirroring. Demonstrate editing with the help of grippers, 3-dimensional design, the ability to work with the commands Iso, 3D-shapes, user coordinate system. Create and stimulate for further development a complex of knowledge of modern methods of visualization in medicine in general, and computed tomography in particular, as well as provide theoretical and practical program skills necessary for understanding and use in the research area.	

languages for solving standard problems in the field of nuclear physics and nuclear engineering. PC-6 Graduates are familiar with basic principles of experimentation; are able to use modern physics measurement methods; are in a position to correctly assess the significance of results; are ready to carry out standard physical experiments, compiling ongoing research and analysis of results; are able to use technical means to measure the main parameters of the objects under study; are able to appropriately write a detailed report on an experiment; to put into practice the research results; to prepare data for the compilation of reviews, reports and scientific publications. PC-7 Graduates are capable of setup, configuration, alignment and experimental verification of instruments and systems used in experimental nuclear physics and nuclear medicine. Graduates are able to use contemporary information technology in the development of new facilities, materials and equipment; teaching technical, circuitry and electrotechnical disciplines in secondary and secondary vocational schools; are capable of collecting and analysing information input for the design of devices and systems; and are able to set up, configure, adjust and experimentally verify hardware and software. PC-8 Graduates are able to reveal the natural-science essence of the problems arising in the course of professional activity, to involve the physics and mathematics apparatus for their solution. Graduates	Form the basis of signal processing and the Fourier transform, the discrete Fourier transform (DFT) and the continuous Fourier transform. Practice image processing techniques. Use point sources and delta functions, a numerical implementation of a two-dimensional Fourier transform. Develop recovery algorithms with coherent radiation sources. Practice the linear integral and the inverse reconstruction of projections. To apply the theorem on the piecewise Fourier transform, three-dimensional filtered back projection, back projection, quantitative analysis is a case of coherent sources. Describe x-ray tomography. Use X-ray projections from monochromatic sources, reverse projection using polychromatic sources. Describe ultrasound computed tomography, magnetic resonance imaging. Detect noise in reconstructed images. Compare continuous and discrete cases. Use data sampling in a real recording system. Analyze tomography with natural sources in diffused light. Illustrate x-ray projections in diffused light. Solve homogeneous and inhomogeneous wave equations. Estimate approximations to the wave equation. Understand the Fourier diffraction theorem. Apply the Green function decomposition and the Fourier transform approach. Develop interpolation and filtered back-projection algorithm for inhomogeneous X-ray sources. Interpolate the image to be restored in the frequency domain.	

must be able to test and analyse standard scientific, engineering, pedagogical problems, to evaluate and select the necessary information, to apply the necessary theoretical and practical methods for the analysis of standard problems, capable of applying their knowledge to solve physics problems in an exemplary manner, to use concepts of nuclear and particle physics in greater depth, thereby acquiring competence in problem solving. PC-9 Graduates are able to take into account current trends in the development of technology in their professional activities. Graduates understand the ideology of research and innovation process by evaluating ongoing technological changes, varying economical situations, modern industrial and environmental trends and issues, and are able to generate creative solutions in the field of their activity. PC-10 Graduates are able to collect, process, analyze and systematize scientific and technical information on the subject of research. Graduates follow the ideas of life-time education in order to continuously raise professional skills and to adequately maintain professional competences.	Develop algebraic recovery algorithms. Demonstrate the image and projection of the object. Apply ART (methods of algebraic reconstruction), SIRT (simultaneous iterative reconstructive technique), SART (method of simultaneous algebraic reconstruction). Describe the patterns of propagation of charged and uncharged particles in a substance. Substantiate the adequacy of dosimetric values of the effects of ionizing radiation on objects of animate and inanimate nature. Explain the statistical nature of natural and man-made radioactivity. Distinguish types of nuclear interaction, radioactive transformations, characteristics of the ionizing radiation field and their units of measurement. Practice the design principles of nuclear radiation detectors. Apply research equipment design methods; on the basic principles of modular electronic systems. Understand the principles of operation, characteristics and capabilities of various electronic devices that allow you to analyze the signal from the detectors used in the experiment. Compare the main types of dosimeters, radiometers, spectrometers and other equipment used in radiation physics, ecology and biology. Use physical methods of radiation registration, ionization chambers and gas meters, trace detectors, magnetic spectrometers, scintillation and semiconductor spectrometers, methods for processing experimental data, evaluating experimental errors and calculating the characteristics of radiation fields. Develop a work program for electronic equipment, master the basics of organizing the measuring and computing process.	

	Distinguish the measurement features of complex distributions. Formulate coding theory in multiparameter analyzers. Use information coding from several detectors, associative systems and preliminary selection of information. Describe multiparameter systems with mass memory, averaging of correlators, correlation time-of-flight spectrometers. Explain why NDT methods were initially developed. Explain why Codes and Standards were initially developed. Describe the uses of NDT. Name the various nondestructive test methods. Briefly explain each NDT method. Describe the advantages and limitations of VT. Explain qualification and certification requirements for VT. Explain the differences between direct and remote VT. Describe manufacturing processes for metals. Explain the discontinuities inherent in various manufacturing processes. Name the various welding discontinuities. Explain the discontinuities inherent in various welding processes Describe the various weld configurations and joint types. Explain the advantages and disadvantages of VT, supplementary welding and NDE symbols, advantages and disadvantages of MT, types of magnetization current, advantages and disadvantages of the RT, why calibration is necessary for UT equipment, principles of alloy identification, principles of UT, mechanics of liquid penetrant Classify types of liquid penetrants, types of deletions, types of developers, types of MT files, types of radioactive sources used for RT, protective equipment to	

	reduce radiation exposure, basic principles of sound. Use the six basic steps for PT testing. Apply removal methods, the UT method with a phased array. Describe the basic principles of MT, types of equipment MT, the basic principles of generating gamma and X-rays, the basics of creating a radiograph. Identify, and accept or reject RT discontinuities based on acceptance criteria. Distinguish four wave modes used for UT. Describe the function of the piezoelectric transducer, the advantages and limitations of ultrasonic testing, types of equipment for the identification of alloys. Compare various ultrasonic scan methods for defect detection, three scan data presentation methods. Understand human physiology, anatomy and evolution of biosignals. Interpret biological signal transducer and measurement concepts. Measure biosignal parameters. Demonstrate the work of all major biomedical engineering. Justify the safety of biomedical devices. Create converters for the application of biosignals, universal safety standards. Analyze the latest trends and events. Determine the role of the clinical engineer in health care management. Argue the importance of the clinical engineer in maintaining safety standards in the clinical environment. Determine the standards for maintenance and repair of medical devices, as well as medical devices for research and design.	

	Discuss the principles, types, measurements of the physiological parameter. Use analytical instruments such as a colorimeter, pH meter. Test and conduct experiments with medical equipment, such as x-rays, ultrasounds, recorders. Apply heat and cold for diagnostic and therapeutic purposes. Describe all the vital mechanisms of the human body related to the fundamental concepts of physics. Apply sound and light for diagnostic and therapeutic purposes. Offer a suitable system depending on the state of the body. Justify the basics of x-ray radiation and its generation and biological effects. Compare various methods of diagnosis of X-rays. Formulate imaging concepts based on magnetic resonance imaging. Understand the properties of ultrasound and the operation of various ultrasonic methods, the principles of the formation of radionuclides. Define the standard of communication of medical images. Compare the principles of operation of a spectrophotometer, a clinical flame photometer, various analyzers of blood gases, various types of audiometers, surgical diathermy, hemodialysis, and various ventilators.	

	Justify the production of lasers, its properties and types. Evaluate the effect of laser tissue interaction. Formulate the characteristics of optical fibers and their application in medicine. Practice the principles of making fibers and bundles of fibers, the basic principle of endoscopy, its use in the diagnosis and therapeutic field. Compare device types, regulations and standards, and medical device approval process. Understand FDA (Food and Drug Administration) terms. Distinguish between components used for different biosensors and biosensor families. Apply biosensors in different areas of instrumentation, various types of photometric methods of analysis. Justify the process of checking the hardware and software of medical equipment. Use practical methods to remove the signal from the radiation detector; process analog and digital signals; experimentally determine noise levels; read and understand schematic diagrams; Independently understand the problems of modern nuclear radiation detection devices. Demonstrate the ability and willingness to use natural scientific knowledge in professional activities. Understand and establish professional tasks in research and practice. Apply advances in nuclear physics research in other areas of knowledge and, in particular, in radiation ecology. Use modern methods of processing experimental data, estimate errors in calculations and	

	experiments. Use application packages for processing experimental data. Select and use recording equipment for conducting nuclear physics experiments and environmental monitoring. Selection, design and design of detectors for all types of emissions. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results. Demonstrate ability by collecting, analyzing and systematizing experimental and theoretical data. Suggest methods of elementary systematics and to formulate the obtained regularities. Design materials in GEANT4, adjust the geometry of the installation and obtain the energy spectrum of radiation with this form of the instrumental line (AFL). Connect the magnetic field in GEANT4 and control particle beams with it, connect optical processes in GEANT4 (scintillation, cutting, absorption and scattering of light). Install a non-monoenergetic source in GEANT4. Get time spectra in GEANT4.Build geometry with repetitive elements in GEANT4. Understand the standard (embedded) PhysicsList set in GEANT4. Simulate a sample calorimeter in GEANT4. Analyze the tasks of research in the field of instrumentation, mathematically simulate the processes and objects of instrumentation and their research on the basis of standard computer-aided design packages and independently developed software products. Carry out measurements and studies of various objects in accordance	

	with this method. Develop design and technological work plans and monitor their implementation, including providing relevant services with the necessary technical documentation, materials and equipment, develop optimal solutions for the creation of instrument-making products with regard to the requirements of quality, cost, execution time, competitiveness and life safety, as well as environmental safety. Establish the order of execution of works and the organization of routes of technological passage of elements and components of devices and systems in the process of their production. Monitor the compliance of projects in development and technical compliance with standards, specifications and other regulatory documents, owners of rules and methods for installing, setting up and adjusting nodes of devices and systems, including those connected with the inclusion of a human operator in the control loop of devices, performing calibration and adjustment and equipment settings, customization of software used for the development, production and configuration of measuring equipment. Develop programs and scripts in Python. Understand and apply modern Python template when needed. Perform basic and advanced analysis of physical experiment data using existing Python libraries. Link Python with external libraries written in C/C ++ programming languages. Develop and implement a graphical user interface for Python programs and scripts. Create file databases and implement data warehouses using the HDF5 file format. Demonstrate acquired knowledge in the field of	

	instrumentation and design in professional activities; Demonstrate an understanding of the general structure, procedures and key elements of the design and design of devices, applying it to the tasks of modern science;Include new received information in the context of knowledge about nuclear physics, instrument making, high energy physics and rethink their content based on this information; Analyze the complex technical situation of designing and manufacturing devices and devices and propose solutions to their tasks; Apply various methods and tools, such as AutoCAD, numerical modeling, mathematical analysis, visualization tools, etc. for various fields of nuclear physics and instrumentation. Demonstrate acquired knowledge of visualization techniques in medical physics and bioengineering. Demonstrate an understanding of the overall structure and key elements of a CT course and its relationship with nuclear physics. Include new information obtained in the context of knowledge of nuclear physics and instrumentation, as well as quantitatively revise its content. Analyze a complex research situation and propose solutions to your problems using computational and visualization tools provided by the course. Apply methods of computational physics, numerical modeling, mathematical analysis, visualization tools, etc. in professional activities in various fields of nuclear physics and engineering.	

	The specialist must have experience: using engineering methods to calculate protection from ionizing radiation sources; radiometric and spectrometric measurements; design of radiometric and spectrometric equipment for nuclear physics experiment and radioecological research; processing experimental data, evaluating experimental errors and calculating the characteristics of the radiation source fields. Independently understand the problems of modern nuclear radiation detection devices. Encode information in multiparameter analyzers. Encode information from multiple detectors. Apply the correlation method in neutron spectrometry.Generate pseudo-random pulses. Conduct a multiparameter experiment. Justify the abbreviations of the NDT method. Determine the VT control tools. Identify the causes, prevention and repair of these welding discontinuities. Indicate welding target and NDE symbols. Describe the basic elements of welding and NDE symbols, measurement of welds. Explain the radioactive half-life. Describe the various types of RT equipment. Explain how radiation measuring instruments are used and types of measuring instruments are listed, how ultrasonic thickness gauges measure the thickness of a thickness, how ECT is performed. Independently understand the problems of modern medical devices. Understand and establish professional tasks in research and practice.	

	Apply knowledge of technology, in particular, in experimental and theoretical research in the field of electronics and devices developing in medicine. Use the studied patterns to understand the processing of medical equipment. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results obtained in the framework of the transition from classical physical to quantum concepts. Demonstrate the ability to analyze and systematize the experimental and theoretical data in the field of medical instruments. Select suitable transducers for use in biosignal. Interpret various biological signals and conduct in-depth analysis. Develop systems for obtaining and measuring various physiological parameters.	
CC-2 Graduates are able to work autonomously, taking initiatives and effectively using time management: able to organize complex efforts over a restricted period of time, producing the required result in a given time-table; have critical and self-critical abilities; able to critically think in scientific terms, state problems, gather data, analyse them and make appropriate conclusions; CC-3 Graduates have proper oral and written communication skills in English needed for professional activities; are able to write and speak correctly according to various communication	The purpose of the educational practice is to train students to solve physical problems and to work with scientific publications. The practice is aimed at developing group efforts in solving complex problems as well as at sharpening student's own understanding by taking part in discussions with other students. The purpose of the Institutional Practice is to fixing of theoretical knowledge of basic and major cycles of disciplines by practical, real performance by the student of duties of the expert, acquisition of practical skills and development of the best practices of professional and organizing work on a profile of future specialty. During the	**7. Practice**

standards in scientific, formal, and informal context; CC-4 Graduates adhere to scientific, engineering and pedagogical ethics required in implementing scientific, engineering and pedagogical activities in complete accord with the accepted practice of professional ethics; CC-5 Graduates comply with the legislations, laws, and legal standards in the fields of health and safety regulations;	work practice, direct training of the student for professional activity in all directions in real working conditions is carried out. During an Institutional Practice data and information for the future bachelor degree project are collected. The students become familiar with technological, organizational and social aspects of the institution or company activity; they study and analyze specialized technical literature, software and other available information sources of the company.	
CC-7 Graduates are socially responsible in adoption of the common well-being of the mankind as a top priority of scientific, engineering and pedagogical activities, ready to bear responsibility for the social, cultural and environmental implications of complex scientific, engineering and pedagogical activities in the context of sustainable development; PC-1 Graduates have sound knowledge of the university mathematics and physics, required for understanding various processes and phenomena in nature and technology; able to use the advanced laws and principles of physics in professional activities, correctly applying methods of mathematical analysis and modelling, theoretical and experimental physics. PC-8 Graduates must be able to test and analyse standard scientific, engineering, pedagogical problems, to evaluate and select the necessary information, to apply the necessary theoretical and practical methods for the analysis of standard problems, capable of applying their knowledge to solve physics problems in	Pre-diploma practice of students is an important part of training and conducted in accordance with the basic specialty curriculum. The main purpose of the pre-diploma practice is to provide theoretical and practical results that are sufficient for the successful implementation and defence of the final qualifying work.	

an exemplary manner, to use concepts of nuclear and particle physics in greater depth, thereby acquiring competence in problem solving. PC-10 Graduates follow the ideas of life-time education in order to continuously raise professional skills and to adequately maintain professional competences.		
CC-2 The graduate is able to work autonomously, taking initiatives and managing time; is able to organize complex efforts over a period of time, producing the required result on schedule; has critical and self-critical abilities; is able to think in scientific terms, propose problems, gather data, analyse them and propose findings; CC-3 The graduate has communication skills (readiness for effective oral and written communication in the course of their professional activities in English; ability to write and speak correctly according to the various communication registers: scientific, formal, informal); CC-6 The graduate has willingness to cooperate with colleagues and to work in a team, able to work with others in a multidisciplinary multi-national setting; CC-7 The graduate is social responsible (adoption of the common good as a top priority of scientific and engineering activity, readiness to bear responsibility for the social, cultural and environmental implications of the complex scientific and engineering activities in the context of sustainable development);	Knowledge of state policy and fundamental achievements of the Republic of Kazakhstan in the field of physical culture and sports. Knowledge of the theoretical, methodological, hygienic and organizational foundations of physical culture and sports. The ability to use in practical life skills, ensuring the preservation and strengthening of health, development and improvement of psycho-physical abilities and qualities. Ownership experience in the use of means of physical culture and sport for disease prevention, mental well-being, development and improvement of qualities and personality traits.	**8. Additional Types of Learning**

Modules, practice	Expected results	Discipline	Activities	Technologies and methods of forming	Monitoring and evaluation tools
1.GENERAL EDUCATION Compulsory Component (21 credits)	Demonstrate the main stages of the modern history of the progressive development of the statehood of Kazakhstan (1991-2014) In the context of world and Eurasian history. Interpret and creatively use scientific, historical and philosophical knowledge to summarize the success factors of the Kazakhstan development model on the way to the statehood of the Republic of Kazakhstan. Competently use language and linguistic and cultural knowledge to solve communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena. Apply automated data processing; explain the purpose, composition, basic characteristics of computer and office equipment, the main methods and means of processing, storing, transmitting and storing information, goals and principles of using application and system software; technological search of information on the Internet, key threats and methods of information security, principles of protecting information from unauthorized access, the legal aspects of the use of information technology and software. Identify major trends in information communications technology; know which economic and political factors contribute to the development of information communication technologies; architectures to be able to calculate and evaluate the performance of supercomputers; features of various operating	Modern History of Kazakhstan Kazakh (Russian) Language Foreign Language Philosophy Information-Communication Technologies	lecture, seminar, laboratory classes IWS	lecture; discussions, discussions, debates; auditory means; reports and communications	the written exam; tests (closed, open); Midterm Control

	systems. In modern conditions, apply the study of the history of the state and law, based on experience and knowledge, in order to recreate an objective picture of the history of the state and the law of the country. Express your thoughts and speak in a foreign language and, respectively, the standards of the spoken language, ask questions and answer them, conduct a conversation in a foreign language in terms of the volume of the subjects being studied, using adequate communication signals to convey the content, read, heard. Develop and defend their scientific position; solve theoretical and methodological issues in the field of science. Use information resources to search and store information; apply methods and means of information protection; design and create simple websites; process vector and raster images; use various forms of e-learning to enhance professional knowledge; use various cloud services.				
2. BASIC DISCIPLINES Compulsory Component (20 credits)	Confidently know the structure of the space of real numbers, the convergence of numerical sequences, understanding the criteria of convergence. Learn the basics of the methods of researching the properties of functions, clearly understand the concepts of the concept of continuity of functions, their differentiability, integrability. To know the basic mathematical concepts involved in the program, their interrelation, interdependence and interaction not only among themselves, but also with other mathematical disciplines. Explain the power and energy characteristics of the electrostatic field, know the relationship between them; the	Mathematics 1 Mathematics 2 Physics 1 Professional Kazakh (Russian) language Basics of	lecture, seminar, laboratory classes IWS	lecture; discussions, discussions, debates; auditory means; reports and communications	the written exam; tests (closed, open); Midterm Control

	principle of superposition; voltage vector flow; Gauss theorem; electric power; current density and current strength; resistance, voltage, electromotive force; laws of direct current; magnetic field induction; flux vector magnetic induction. Successfully apply the circulation theorem; Ampere's law and Lorentz force. Know the physical interpretation of inductance; electromagnetic induction law. Apply the theory of a harmonic oscillator and related concepts (frequency, phase, amplitude, energy); the relationship between amplitude, frequency and energy of a harmonic oscillator. Apply modern vocabulary and terminology in Kazakh (Russian) and English for technology and project management methodology, project management processes, modern project management software. In the process of training, future specialists will learn the basics of the theory of conversion and production of signals, the most important electrical quantities, units of measurement, transformations, calculation and modification of various components of electronic devices. In the process of training, future specialists will master the basic ray tracing; imaging systems; advanced ray tracing: Hamiltonian optics; optical system design; scalar linear wave propagation; wave properties of light and polarization. Master at a high level the necessary information for the intensification of production processes, the construction of fully automated production facilities. Correctly apply the basic methods of mathematical analysis to solve various mathematical problems; acquire practical skills for solving problems, correctly choose a method for solving	electronics Physics 2 Electrical Engineering Professionally-Oriented Foreign Language			

	problems and solve them; put into practice the differentiability and integrability of numerical methods. Know the specific conditions of convergence of numerical methods. Acquire practical skills in applying differential and integral calculus in problems of mechanics and physics. Accurately and thoroughly substantiate the reasoning, without cluttering it with unnecessary details. Find characteristics of electric, magnetic (in vacuum and matter) and gravitational fields and thermal equilibrium radiation using Maxwell's equations and elements of field theory (vector and scalar fields). Find forces acting on the charged particles in the electric and magnetic fields, as well as their combined effect on the conductors with a current in a magnetic field. Determine main parameters of electric currents in vacuum, gases, plasma. Find main characteristics of free harmonic, damped, as well as forced oscillations and resonance, which includes elements of the theory of functions of a complex variable and differential equations. Find energy, amplitude and speed of wave propagation. Be able to implement systematic theoretical and basic knowledge in various educational spaces, use practical skills to set simple research tasks, own a professional speech culture. Master the basic principles of construction and operation of electronic devices, use the achievements of electronics in various fields of professional activity. Understand the theory of interference and the use of interferometers. Describe spatial filtering, coherent and				

	incoherent imaging. Explain wavefront modulation, holography, diffraction optics, subwave optics: “nanophotonics”, “metamaterials”. In the process of training, future specialists will learn the basics of the theory of electrical circuits, the most important electrical quantities, units of measurement, the production and transmission of electrical energy, the transformation, calculation and modification of various power devices.				
3. MAJORS Compulsory Component (5 credits)	Understand and put into practice: the structure and operation of microprocessors; technology of integration and technological condition of microprocessor structure properties. Interpret progress, trends and microprocessors review. Describe the structure and operating systems of microprocessors; technology, parameters and operation of memories; input / output systems; programming and activation of the development of microprocessor systems. Analyze the basics of development and creation of information and measurement systems, such as technical systems and functioning basic information and measurement systems, as hardware and software. Classify measurements, showing the characteristic specific features and features of the methods and the validity of the measurement processes. Apply major models of FPGA. Use the software environment. Design various digital electronic circuits. Use devices for programming logic integrated circuits. Solve problems by applying the features of FPGA. Use circuits with different characteristics.	Integraal and microprocessor circuitry Basics of Information and Measurement Technologies	lecture, seminar, laboratory classes IWS	lecture; discussions, discussions, debates; auditory means; reports and communications	the written exam; tests (closed, open); Midterm Control

	Use real measurement hardware and software. Apply virtual information and measuring systems using modern information and modeling technologies of various types, including computer, mathematical, physical, with extensive use of computer, which helps to conduct experimental measurements.				
4. GENERAL EDUCATION Elective Course (8 credits)	At a professional level, know structured programming. Analyze and develop algorithms. Master the syntax and semantics of C; logical and syntax debugging; basics of software development. Apply the theory of algebraic equations, the basic properties of determinants and matrices, an algebraic and geometric description of lines and surfaces of second order, introductory information about groups, rings and fields. Apply basic mathematical concepts and fundamentals of vector algebra to teach general physics courses, such as mechanics or molecular physics. Interpret basic mechanical models and phenomena; mechanical laws and concepts, the limits of their applicability, allowing them to be effectively used in specific situations. Understand the main technospheric and artificial hazards, their properties and characteristics, the nature of the impact of harmful and dangerous factors of production on humans and the environment, methods of protection against them; legislation and legal acts in the field of life safety, methods and technologies of protection in emergency situations; future specialists will acquire the theoretical knowledge and practical skills necessary to create safe and harmless living conditions; identify the main hazards of the human environment, assess the risk of their implementation. Use elementary methods using arithmetic operators and mathematical expressions in C ++ programming.	Computer science Analytical geometry Occupational Safety and Health	lecture, seminar	lecture; discussions, discussions, debates; auditory means; reports and communications	the written exam; tests (closed, open); Midterm Control

	Choose the appropriate data type to represent the data. Write C ++ programs that use choices (if, switch, conditional statement). Write C ++ programs that use loops (while, dowhile, for). Write C ++ programs that use sequential files for input and output. Write C ++ programs that use functions to transfer control. Write C ++ programs that use arrays, including sorting and searching for arrays. Write C ++ programs that use pointers. Solve programming problems with C ++. Understand how to accurately and carefully state the essence of a particular problem without cluttering it with unnecessary details. Get an idea of how to solve problems of mathematical analysis, algebra and analytical geometry. Acquire practical skills to solve problems, to use a specific mathematical method to reduce the problem to its simplest expression and choose the way to solve it. Continue education with a high degree of autonomy. Apply modern mathematical tools to solve and analyze problems of mechanics, physics and the natural sciences. Interpret the content of the discipline, including new knowledge. Analyze educational problems and suggest ways to solve them. Apply the methods (research, calculation, analysis, etc.) inherent in the field of analytical geometry. Synthesize, interpret and evaluate the learning outcomes of analytic geometry, modules, intermediate exam level. Understand the modern concepts of natural and man-made				

	processes that cause a violation of safety requirements for life, environmental protection, make decisions in emergency situations and protection. Apply monitoring and measurement methods in the field of safety and environmental protection. To possess methods and technologies of protection in emergency situations. Use knowledge about the organization of security in emergency situations at the facilities of the economy, in everyday life, in the environment.				
4. BASIC DISCIPLINES Elective Course (49 credits)	Apply basic concepts and laws in mechanics; kinematic equations; Newton's laws of dynamics; free body diagrams; conservation laws for determining the movement of physical bodies; basic concepts and laws in thermodynamics; basic concepts and laws in the phenomena of transference. Interpret the main laws, concepts and theories of chemistry and its understanding; physical and chemical properties of elements; elements of the periodic system of Mendeleev and its understanding. Understand the concept of a good quantum number and simultaneous observability. Understand quantum numbers, including their physical significance, and the quantum mechanical states of the hydrogen atom. Understand the origin of the width and shape of lines in atomic spectra. Know about the origin of the fine structure in atomic spectra. Understand the exchange degeneracy and how it affects the	Mechanics and molecular physics Chemistry Atomic physics Computer simulation Probability theory Basics of materials science Circuitry of	lecture, seminar laboratory classes IWS	lecture; group mini-projects; individual practice-oriented projects laboratory and practical work	the written exam; tests (closed, open); Midterm Control the solution of problems; the Colloquium

	excited states of helium. Understand the conclusion and the possibility of applying the selection rules for the interaction of electric dipole radiation and atoms. Know about Einstein's A and B coefficients and their relationships. Understand modern programming languages, experimental data processing and numerical simulation of a physical experiment, including Matalb, C ++, Microsoft Visual Studio and others. Knowledge of programming languages includes algorithms, variables, and basic structures; C ++ variable types basic arithmetic operations. Use numerical methods to solve ordinary differential equations, including the differential equations of motion of Newton. Solve problems of a body thrown at an angle to the horizon and rebounding from perpendicular to the movement of the walls; the problem of a ball rolling down a rigid ladder, etc. Understand and apply the Verlet algorithm and its variations. Numerically interpret the conservation laws in Newton's dynamics for the purpose of computer simulation. Must know the method of application of the iteration of the Picard process, the modified Euler method, the predictor-corrector method; frog jump method and Euler-Cromer algorithm for solving an ODE. Have working knowledge of data formatting procedures and their recording in a file for further processing and visualization. Apply elements of the theory of the numerical solution of nonlinear differential equations; stability of the numerical solution. Distinguish between types of equations of the order above the	measuring devices Basics of automation Nuclear physics Designing of devices on FPGA Theory of measurements Dosimetry and protection from radiation Statistical processing and interpretation of nuclear physics experimental			

	first, which can be reduced to a system of differential equations7 Use numerical integration, including trapezoidal formulas, rectangle formulas, Simpson's rule, etc. Know the methodologies of applying numerical methods for modeling the motion of charged particles in electric and magnetic fields, computer models of Kepler's laws, rotation and rotational motion, Rutherford scattering, Coulomb interaction between two free charges. Working knowledge of the use and construction of Newton and Lagrange interpolation polynomials. Must know Fourier series; Fourier transform; Fourier series of some special functions. Complex form of Fourier series. Own the theory of random numbers; pseudo-random number generators. Apply methods for the numerical solution of the Schrödinger equation using the variational method. Apply probability theory and its understanding (random event, definition of probability, basic probability formulas, independent research, random variables, etc.). Formation of students' knowledge of the principles of action, parameters and features of the main classes of modern semiconductor devices and integrated circuits and operating modes; Formation of students' knowledge of the basic principles of analog electronic devices (AEU) circuit technology and methods for their analysis. Must know the principles of action and feedback, i.e. response, construction methods and the study of various systems and individual technical tools and automation methods. By this is meant: Knowledge of impulse devices; parameters and features of pulse	data Detectors of nuclear radiation Interaction of radiation with matter Microcontrollers and their application Spectrometry Computer technologies in instrument making			

	and variable signals; linear elements for impulse devices; RC and RL circuits; switches based on transistors. Understand how switches work; symmetric and asymmetric triggers. Apply basic trigger schemes, as well as blocking generators; linear voltage alternator; linear voltage generator Demonstrate the mode of operation of the comparator. Use discriminators to analyze pulse signals. Master the basic principles of discrete automation. Boolean and other logical functions. Truth tables for Boolean Laws and their statements. Apply gates on MOS transistors, design complex logic gates and devices, and also synthesize combined devices on logic elements. Demonstrate the synthesis of incompletely defined logical functions and logic devices with multiple outputs. Explain the characteristics of digital devices; calculus systems; performing arithmetic operations; integrated logic circuit. Apply encoders, decoders, code converters; multiplexors and demultiplexes; programmable logic array of elements. Demonstrate the operation of addressable registers, electronic meters and adders and their application; analog-to-digital converters; electronic valves for storing information and schemes for their implementation. Apply digital circuit control devices; digital schematics of control devices of the circuit and software design. To understand the basic architecture and principles of action; linear and parallel computing paradigms; CPUs and their architecture; input - output and device interfaces; external storage devices; microcontrollers and programmable microcontrollers. Demonstrate knowledge of the theory of the structure of the atomic nucleus. Apply types and patterns of radioactive decay;				

	effective cross sections and methods for their measurement; the laws of the passage of radiation through matter; mechanisms of nuclear reactions and their types; the physical basis for using the properties of nuclei and nuclear radiation in science and technology; basic laws of fission and nuclear fusion. Interpret theoretical and practical information about the basic principles of FPGA programming and task options for the main sections of programming and construction, as well as tasks that require logical reflection for students in the performance of laboratory and independent work. Understand the nature and features of the measurement process. To master the methods of temperature measurement: thermoelectric and thermoresistive; temperature measurement by thermomagnetic method; temperature measurement by pyrometric methods. Apply measuring and control devices; generalized block diagram of measuring and control devices; metrological characteristics of measuring and control devices. Explain the classification of physical quantities; absolute and relative measurement errors; weight tools. Use measuring and control devices with mechanical, optical, optical-mechanical, pneumatic and radioactive transducers. Master the methods of measuring and controlling thermal values. Apply methods and means of measuring and controlling temperature; methods of measurement and control of electrical and magnetic quantities; means and units of measurement. Interpret the theory of measurement of optical radiation. Master the basic concepts of measurement theories. Master the methods of measuring acoustic values;				

	measurement of pressure, quantity and flow of gases and liquids. Describe test methods for measuring and controlling instruments. Understand the basic concepts of dosimetry and radioactive sources. To establish the connection of the nuclear-physical mechanisms of interaction of ionizing radiation with biological matter. Understand the laws, patterns, systematics, effects and phenomena in the field of applied science on the creation of the core of nuclear reactors; in the field of science - concrete examples of the introduction of powerful nuclear power plants. Assess the main regulatory framework for nuclear energy and radiation safety of the population of the Republic of Kazakhstan. Determine the basic principles of radioactive waste storage. Apply basic sanitary and epidemiological standards for radiation safety for both staff and the public. Practice evidence-based workplace organization methods in accordance with general and special precautionary regulations. Experimentally determine alpha, beta and gamma background both indoors and in an open atmosphere. To be able to localize and eliminate the consequences of radiation accidents at various levels. To understand the objective laws of physical processes on a microscale scale; methods for recording ionizing radiation. Demonstrate methods and means of measuring and quantifying radiation. Apply the main types of interaction of neutrons and materials, their characteristics, methods of observation and experimental research. Explain statistical distributions, their concepts and applications.				

	Apply histogram basics, maximum similarity method, chi-square distribution, fitting (fitting), frequent and Bayesian approaches, basics of the ROOT structure. Understand different approaches to fitting, installation with a ROOT card. Understand the meaning of quality reduction, the basics of multidimensional analysis, data storage with the help of ROOT. Classify types (such as gas-filled detectors: simple ionization chambers, proportional, Geiger-Muller counters, semiconductor detectors: pn-junction, lithium drift, high-purity germanium, scintillation detectors: NaI (Tl), organic) and characteristics of detectors for high-energy radiations they work, and how they are used. Use electronic systems to detect and measure radiation. Explain the characteristics and use of nuclear detectors and the calculation of their properties (efficiency, energy resolution, temporal resolution, resolution of a pair of pulses, dead time). Compare the properties of different detectors and select the detector that is most suitable for this application. Describe qualitatively and quantitatively the result of measuring a certain radiation using a specific radiation detection system. Understand the basic concepts and mechanisms of interaction of radiation with matter. To determine the processes occurring during the interaction of accelerated charged particles, neutrons and gamma quanta with atoms and nuclei of atoms of matter. Acquire scientific skills and conduct independent research work (thesis) in the field of nuclear physics and elementary particles. Understand the basic concepts of the laws of the flow of physical processes in major nuclear physics research and power plants. To keep abreast of current issues and unresolved issues of				

	nuclear physics and technology. Understand the general laws of radioactivity in the natural environment and the theory of radiation sources. Apply methods and means of measuring and quantifying them. Summarize the results of applying the methods for calculating the modulusless nuclear parameters and the energy characteristics of the reaction nuclei and nuclear fuel. Familiarize yourself with the methodology, general principles and methods of mathematical physics. To possess highly specialized advanced theoretical knowledge and practical skills that are the basis for research and an original approach to solving professional problems. Understand the methodology and methods of empirical treatment (research) of the material and be able to use them in scientific and practical activities. Classify the architecture and command systems of microprocessors, principles of organization of microprocessor systems, as well as types of development of microprocessor technology based on microcontrollers. Apply modern methods of developing modern microprocessor technology by selecting microcontrollers (microprocessors) and programming microprocessor devices using appropriate software and tool environments. Evaluate the results of the use of microcontroller programming methods and the development of specific microprocessor technology based on them. Understand the basic concepts and concepts of graphical programming in LabVIEW. Demonstrate the basics of programming in the LabVIEW environment and options for tasks for the main sections of programming and design, as well as tasks				

	that require logical thinking for students to perform laboratory and homework. Understand the concepts and basic functions of graphical programming in LabVIEW, as well as be able to apply the knowledge gained in solving various physical and technical problems. Apply the basic methods and applications of nuclear spectrometry of gamma radiation, light and heavy charged particles, as well as neutrons. Understand the properties and characteristics of ionizing radiation, the main processes of interaction of charged particles, neutrons and photons with the matter of the detectors, the properties and characteristics of gamma radiation from sources of radionuclides. Use physical methods of radiation detection, methods for processing experimental data, evaluating experimental errors and calculating specific loads, methods for conducting radiometric and spectrometric measurements, modern methods of using information and communication technologies in a chosen field of activity. Analyze modern methods of designing and manufacturing devices and devices. Apply the Matlab integrated development environment. Understand the main variables and structures, definitions, accuracy and their use, basic operations and operators. Analyze the results of the implementation of ODE solutions in Matlab and the Picard iteration process. Demonstrate the stability and convergence of the modified Euler method and the Euler-Cromer algorithm. Distinguish scalars, vectors, matrices, and multidimensional arrays in Matlab. Evaluate memory usage and allocation. Analyze				

	the predictor-corrector method and the Leap-frog method of graphical implementation, 2D and 3D graphics. To distinguish nonlinear differential equations, to determine the stability of a numerical solution. Evaluate boundary conditions from graphics. Understand the loops in Matlab. Use cycles to calculate the sums and products of numerical series. Use custom functions to calculate factorial, polynomial and other special functions. Apply the fourth order Runge Kutta method. Calculate RLC circuits, charge and voltage diagrams. Describe Rutherford scattering in a laboratory system. Check the limit model of a noninteracting particle beam. Interpret the Coulomb interaction between two free charges and the scattering of a noninteracting particle beam by a massive charge. Apply methods for modeling the interaction between several particles in a closed space and periodic boundary conditions. Describe the ideal gas in three-dimensional space. Apply Fourier spatial filters, low and high pass filters. Understand random numbers, pseudo-random number generators. Demonstrate estimates of areas by the Monte Carlo method and numerical calculation of multidimensional integrals. Solve the classical differential equations. Transform the physical situation, formulated in English, into a mathematical formulation. Apply basic mathematical tools, including vectors and calculus, to solve physical problems. Make use of physical intuition, including the ability to guess an approximate or conceptual response to a physical problem. Analyze the result of the calculation. Apply physical knowledge to other disciplines, including physics and				

	engineering. To illustrate how physical observation, experiment, and theory worked together to develop inventions that advanced our civilization. Solve practical problems of chemistry. Offer optimal reaction conditions. Writing a scheme about converting chemicals from each other. Demonstrate acquired theoretical knowledge when passing intermediate and final exams. Experimenting reactions in the laboratory during laboratory classes and the use of various laboratory equipment and facilities. Analyze the results of educational activities of chemistry, their synthesis through scientific essays, presentations, etc. Understand and be able to apply time-dependent perturbation theory to simple cases. Understand the periodic table in terms of electronic structure. Understand time-independent perturbation theory, including its derivation, and be able to apply it to simple systems, including the Stark and Zeeman effects. To be able to solve problems in atomic physics. To have the skills of scientific programming, to interpret and evaluate the results of training during the course of listening to the course and its individual modules, to be confident in passing the intermediate and final exams; Perceive in dynamics the process of numerical solution of scientific problems and predict its result; Compile a complete and competent quantitative analysis of the results of his study for the course, summarize its main ideas through scientific essays, scientific programming and writing code, etc.				

	Have the skills to participate in educational and social interaction within the group and the educational environment created for this course; Have the skills of accepting and analyzing the task, perceive its importance and anticipate a numerical decision, accept criticism and be able to criticize, work in a team. The ability to recognize the important integral role of the course being listened to in the implementation of an individual learning path. Demonstrate an understanding of the general structure of probability theory and the relationship between its elements, including new knowledge in the context of basic knowledge, and interpret its content. Analyze educational problems and suggest directions for their solution and methods of use (research, calculations, analysis, etc.) inherent in the field of probability theory for study individually or in a group, training and research activities. Synthesize, interpret and evaluate the results of the theory of probability, modules, average exam level. Analyze the dynamics of solving scientific problems of probability theory (scientific reviews of specific problem studies), as well as the skills of selecting and building AEU nodes. Explore measurement technologies that combine a combination of methods, approaches, software, and logical support for the organization of measurements; conditions and trends in the development of measuring instruments and basic methods for measuring the characteristics of electronic circuits and signals and assessing their accuracy. Analyze the automatic control system and select the main automation devices.				

	To be able to see and implement, in theory and practice, the basic idea of automatic and automated control, types of automation systems, features and values of automation of agricultural production, synthesis of automatic control systems. Interpret and evaluate the results of the training activities of the course and its individual modules, to be sure, when faced with certain content of the mid-term and final exam. To be able to constructively participate in the educational and social interaction in the group and the educational environment created for this course. Analyze a problem, feel its importance and foresee a numerical decision, take criticism and be able to criticize and work in a team.Use this knowledge in practice. Conduct assessments and engineering calculations of the results of nuclear transformations. Work with nuclear physics equipment. The main methods of nuclear physics research. Use sources and detectors of nuclear radiation. Understand the fundamental concepts and syntax of the Verilog programming language, theoretical and practical information about the basic principles of FPGA programming and task options for the main sections of programming and construction, as well as tasks that require logical reflection for students when performing laboratory and independent work. Develop and understand the concept and basic functionality of modern programmable logic integrated circuits, as well as the application of the knowledge gained, in solving various physical and technical problems. Understand the principles of the measurement process, the metrological characteristics and modes of operation of measuring				

	devices, ensuring the uniformity of measurements, issues of potential measurement accuracy. Be able to optimize the measuring experiment in various measurement conditions and environmental effects; Perform operations with various types of measurement information. Apply practical skills of general measurement theory to experimentally solve simple tasks.It is correct to choose measuring instruments in accordance with the required accuracy of the measurement result. Methodically correctly measure typical physical quantities and process measurement results. Apply fundamental knowledge of the laws of nuclear physics, in particular, in experimental and theoretical methods for calculating protection against ionizing radiation. Apply basic sanitary and epidemiological standards for radiation safety for both staff and the public. Practice evidence-based workplace organization methods in accordance with general and special precautionary regulations. Experimentally determine alpha, beta and gamma background both indoors and in an open atmosphere. Be able to localize and eliminate the consequences of radiation accidents at various levels. Demonstrate skills during presentations at scientific conferences and seminars on the physical understanding of the results obtained in the application of sanitary and epidemiological norms. Understand the differences between statistical distributions and the ability to apply a proper distribution. Fit models to observations using different methods: maximum probability, chi-square.				

	Apply frequency and Bayesian approaches to testing hypotheses. Use ROOT structures for analyzing experimental data in nuclear physics: fitting, multidimensional analysis, data storage and recovery. Independently understand the problems of modern nuclear radiation detection devices. Demonstrate ability and readiness. Use natural scientific knowledge in professional activities. Understand and establish professional tasks in research and practice. Apply advances in nuclear physics research in other areas of knowledge and, in particular, in radiation ecology. Use modern methods of processing experimental data, estimate errors in calculations and experiments. Use application packages for processing experimental data. Select and use recording equipment for conducting nuclear physics experiments and environmental monitoring. Selection, design and design of detectors for all types of emissions. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results. Demonstrate the ability to collect, analyze and systematize experimental and theoretical data. Propose methods of elementary systematics and to formulate the obtained laws.Independently understand the problems of modern nuclear radiation detection devices. Apply fundamental knowledge of the laws of quantum physics, in particular, in experimental and theoretical studies in the field of nuclear reaction and decay of radioactive nuclei, the laws of				

	nuclear fission, nuclear thermonuclear physics and nuclear astrophysics. Use the studied patterns to understand the physics of cosmic rays, nuclear decays in the Earth's lithosphere and the radiation processes occurring in living matter. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results obtained in the framework of the transition from classical physical to quantum concepts. To demonstrate the ability to collect, analyze and systematize the experimental and theoretical data on the spectra of nuclear radiation and their dependence on the structural characteristics of the nucleus. To propose methods of elementary systematics of the parameters of the nuclear structure and nuclear reactions and to formulate mathematically the obtained laws. Formulate the problem when working together in the framework of complex teams of experimental physicists and theoretical physicists, correctly formulate the goals and objectives of the study or practical application. Convince the audience of the need to use nuclear technology for practical purposes to justify their safety and reliability. Demonstrate skills in the study of new areas of the physics of the microworld. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results. Demonstrate the ability to collect, analyze and systematize experimental and theoretical data. To propose methods of elementary systematics and to formulate the obtained laws. Understand the architecture of microprocessors and microcontrollers. Understand the principles of the organization of microprocessor technologies and modern methods of designing				

	microprocessor technology. To put into practice the basic methods of programming microcontrollers. Develop hardware for digital devices. Designing various microprocessor based devices. Qualitatively select and use recording equipment for conducting experiments in nuclear physics and environmental monitoring. Qualitatively choose, make engineering calculations and design detectors of all types of emissions. Apply methods for processing experimental data, evaluating experimental errors and calculating the characteristics of radiation source fields. Solve the problems of nuclear spectroscopy. Have experience in the use of Internet resources in the course of research, including in a foreign language. Demonstrate acquired knowledge of programming languages and software development environments in professional activities. Demonstrate an understanding of the overall structure, procedures, and key elements of the modeling toolkit (IDE). To have the opportunity to incorporate new information obtained in the context of nuclear physics and high energy physics and to rethink its content on the basis of this information. Analyze the complex situation of designing and manufacturing devices and devices and propose solutions to their problems; Apply methods and tools such as Matlab, Simulink, numerical modeling, mathematical analysis, visualization tools, etc. for various fields of nuclear physics and instrumentation.				
5. Individual educational	Solve the problem of processing analog and digital signals. Describe the characteristics and structure of the amplifiers.	Nuclear electronics	lecture, seminar	lecture; group mini-	the written exam;

trajectories (IET) (27 credits) **IET 1**	Distinguish classification and parameters of logical elements on integrated circuits. Use memory devices (triggers). Understand the characteristics and use of nuclear detectors and the calculation of their properties (efficiency, energy resolution, temporal resolution, resolution of a pair of pulses, dead time). Compare the properties of different detectors and select the detector that is most suitable for this application. Describe qualitatively and quantitatively the result of measuring a certain radiation using a specific radiation detection system. Understand the basic concepts of a modeling package in GEANT4, how to change input parameters. Simulate and learn how to work with the g ++ compiler (GNU c ++ compiler). Familiarize with basic bash commands. File Manager Midnight Commander Linux. Familiarize with the installation procedure of GEANT4 simulation package on Linux and Windows platforms. Familiarize with viewing VRML files with DeepExploration viewer. The principles of operation of individual detectors and the entire range of courses, all advanced global research, the natural scientific essence of problems arising in the course of professional activity, involve the physical and mathematical apparatus for solving them, technological processes of production, metrological guarantees and quality control of elements of devices for various purposes. The basic principles of programming Python. Understand the syntax of the language, features of Python and programming patterns. Use modern python libraries to analyze scientific data:	Simulation of nuclear physics setups Instrument making in advanced nuclear physics experiments Basics of Python programming language Technology of designing devices and systems Computerized tomography methods Automation of acquiring data from coordinate-sensitive and track detectors	laboratory classes IWS	projects; individual practice-oriented projects laboratory and practical work; the case study project	tests (closed, open); Midterm Control

	numpy, scipy, matplotlib. Analyze the main scientific data: statistics, construction, installation. Conduct advanced data analysis of specific experiments. Demonstrate Python binding to C/C ++ languages. Work with a graphical user interface with Python and work with the HDF5 data format. Study and qualitatively accumulate knowledge about modern methods of designing and manufacturing devices and devices. Interpret the place of science and design methods in the life cycle of the measuring device. Apply block hierarchical approach, functional design of the measuring device. Principles of construction of devices and systems. Classify devices and systems. Develop a mathematical model of the measuring device, a mathematical model of the device for the static measurement mode, a mathematical model of the device for the dynamic measurement mode. Understand the static characteristics of the measuring device. Calculate the sensitivity coefficient of the measuring device, the error of the nonlinearity of the static characteristics of the measuring device. Distinguish dynamic and static characteristics of the measuring instrument/device, as well as characteristics of the measuring signals. Classify the types of dynamic characteristics of the measuring device, types of measuring signals, types of signal characteristics, characteristics of deterministic signals, energy and spectral characteristics. Analyze the calculated dynamic and static parameters, the accuracy of the measuring device. Equation of measurement error. Evaluate measurement errors at the design stage of a measuring device.	Multiparameter and correlation measurements Devices for non-destructive testing			

	Develop models of the measuring signal and calculate additive noise and total errors.Understand the basics of measuring instrument reliability. Classify the types of instrument performance. Organize research projects, design process, development work. Possess AutoCAD user interface, AutoCAD Cartesian workspace. Use commands to modify an existing drawing file. Select objects for editing, moving, copying, rotating, scaling, mirroring. Demonstrate editing with the help of grippers, 3-dimensional design, the ability to work with the commands Iso, 3D-shapes, user coordinate system. Create and stimulate for further development a complex of knowledge of modern methods of visualization in medicine in general, and computed tomography in particular, as well as provide theoretical and practical program skills necessary for understanding and use in the research area. Form the basis of signal processing and the Fourier transform, the discrete Fourier transform (DFT) and the continuous Fourier transform. Practice image processing techniques. Use point sources and delta functions, a numerical implementation of a two-dimensional Fourier transform. Develop recovery algorithms with coherent radiation sources. Practice the linear integral and the inverse reconstruction of projections. To apply the theorem on the piecewise Fourier transform, three-dimensional filtered back projection, back projection, quantitative analysis is a case of coherent sources. Describe x-ray tomography. Use X-ray projections from monochromatic sources, reverse projection using polychromatic sources.				

	Describe ultrasound computed tomography, magnetic resonance imaging. Detect noise in reconstructed images. Compare continuous and discrete cases. Use data sampling in a real recording system. Analyze tomography with natural sources in diffused light. Illustrate x-ray projections in diffused light. Solve homogeneous and inhomogeneous wave equations. Estimate approximations to the wave equation. Understand the Fourier diffraction theorem. Apply the Green function decomposition and the Fourier transform approach. Develop interpolation and filtered back-projection algorithm for inhomogeneous X-ray sources. Interpolate the image to be restored in the frequency domain. Develop algebraic recovery algorithms. Demonstrate the image and projection of the object. Apply ART (methods of algebraic reconstruction), SIRT (simultaneous iterative reconstructive technique), SART (method of simultaneous algebraic reconstruction). Describe the patterns of propagation of charged and uncharged particles in a substance. Substantiate the adequacy of dosimetric values of the effects of ionizing radiation on objects of animate and inanimate nature. Explain the statistical nature of natural and man-made radioactivity. Distinguish types of nuclear interaction, radioactive transformations, characteristics of the ionizing radiation field and their units of measurement. Practice the design principles of nuclear radiation detectors. Apply research equipment design methods; on the basic principles of modular electronic systems. Understand the principles of operation,				

	characteristics and capabilities of various electronic devices that allow you to analyze the signal from the detectors used in the experiment. Compare the main types of dosimeters, radiometers, spectrometers and other equipment used in radiation physics, ecology and biology. Use physical methods of radiation registration, ionization chambers and gas meters, trace detectors, magnetic spectrometers, scintillation and semiconductor spectrometers, methods for processing experimental data, evaluating experimental errors and calculating the characteristics of radiation fields. Develop a work program for electronic equipment, master the basics of organizing the measuring and computing process. Distinguish the measurement features of complex distributions. Formulate coding theory in multiparameter analyzers. Use information coding from several detectors, associative systems and preliminary selection of information. Describe multiparameter systems with mass memory, averaging of correlators, correlation time-of-flight spectrometers. Explain why NDT methods were initially developed. Explain why Codes and Standards were initially developed. Describe the uses of NDT. Name the various nondestructive test methods. Briefly explain each NDT method. Describe the advantages and limitations of VT. Explain qualification and certification requirements for VT. Explain the differences between direct and remote VT. Describe manufacturing processes for metals. Explain the discontinuities inherent in various manufacturing processes. Name the various welding discontinuities. Explain the discontinuities inherent in various welding processes Describe the various weld configurations and joint types. Explain the				

	advantages and disadvantages of VT, supplementary welding and NDE symbols, advantages and disadvantages of MT, types of magnetization current, advantages and disadvantages of the RT, why calibration is necessary for UT equipment, principles of alloy identification, principles of UT, mechanics of liquid penetrant Classify types of liquid penetrants, types of deletions, types of developers, types of MT files, types of radioactive sources used for RT, protective equipment to reduce radiation exposure, basic principles of sound. Use the six basic steps for PT testing. Apply removal methods, the UT method with a phased array. Describe the basic principles of MT, types of equipment MT, the basic principles of generating gamma and X-rays, the basics of creating a radiograph. Identify, and accept or reject RT discontinuities based on acceptance criteria. Distinguish four wave modes used for UT. Describe the function of the piezoelectric transducer, the advantages and limitations of ultrasonic testing, types of equipment for the identification of alloys. Compare various ultrasonic scan methods for defect detection, three scan data presentation methods. Design materials in GEANT4, adjust the geometry of the installation and obtain the energy spectrum of radiation with this form of the instrumental line (AFL). Connect the magnetic field in GEANT4 and control particle beams with it, connect optical processes in GEANT4 (scintillation, cutting, absorption and scattering of light). Install a non-monoenergetic source in GEANT4. Get time spectra in GEANT4.Build geometry with repetitive elements in GEANT4. Understand the standard (embedded) PhysicsList set				

	in GEANT4. Simulate a sample calorimeter in GEANT4. Analyze the tasks of research in the field of instrumentation, mathematically simulate the processes and objects of instrumentation and their research on the basis of standard computer-aided design packages and independently developed software products. Carry out measurements and studies of various objects in accordance with this method. Develop design and technological work plans and monitor their implementation, including providing relevant services with the necessary technical documentation, materials and equipment, develop optimal solutions for the creation of instrument-making products with regard to the requirements of quality, cost, execution time, competitiveness and life safety, as well as environmental safety. Establish the order of execution of works and the organization of routes of technological passage of elements and components of devices and systems in the process of their production. Monitor the compliance of projects in development and technical compliance with standards, specifications and other regulatory documents, owners of rules and methods for installing, setting up and adjusting nodes of devices and systems, including those connected with the inclusion of a human operator in the control loop of devices, performing calibration and adjustment and equipment settings, customization of software used for the development, production and configuration of measuring equipment. Develop programs and scripts in Python. Understand and apply modern Python template when needed. Perform basic and advanced analysis of physical experiment data using existing Python libraries. Link Python with external libraries written in C/C				

	++ programming languages. Develop and implement a graphical user interface for Python programs and scripts. Create file databases and implement data warehouses using the HDF5 file format. Demonstrate acquired knowledge in the field of instrumentation and design in professional activities; Demonstrate an understanding of the general structure, procedures and key elements of the design and design of devices, applying it to the tasks of modern science;Include new received information in the context of knowledge about nuclear physics, instrument making, high energy physics and rethink their content based on this information; Analyze the complex technical situation of designing and manufacturing devices and devices and propose solutions to their tasks; Apply various methods and tools, such as AutoCAD, numerical modeling, mathematical analysis, visualization tools, etc. for various fields of nuclear physics and instrumentation.				
5. Individual educational trajectories (IET) (27 credits) **IET 2**	Understand human physiology, anatomy and evolution of biosignals. Interpret biological signal transducer and measurement concepts. Measure biosignal parameters. Demonstrate the work of all major biomedical engineering. Justify the safety of biomedical devices. Create converters for the application of biosignals, universal safety standards. Analyze the latest trends and events. Determine the role of the clinical engineer in health care management.	Medical physics Medical instruments and medical engineering Clinical engineering Medical electronics Medical	lecture, seminar laboratory classes IWS	lecture; group mini-projects; individual practice-oriented projects laboratory and practical work; the	the written exam; tests (closed, open); Midterm Control

	Argue the importance of the clinical engineer in maintaining safety standards in the clinical environment. Determine the standards for maintenance and repair of medical devices, as well as medical devices for research and design. Discuss the principles, types, measurements of the physiological parameter. Use analytical instruments such as a colorimeter, pH meter. Test and conduct experiments with medical equipment, such as x-rays, ultrasounds, recorders. Apply heat and cold for diagnostic and therapeutic purposes. Describe all the vital mechanisms of the human body related to the fundamental concepts of physics. Apply sound and light for diagnostic and therapeutic purposes. Offer a suitable system depending on the state of the body. Justify the basics of x-ray radiation and its generation and biological effects. Compare various methods of diagnosis of X-rays. Formulate imaging concepts based on magnetic resonance imaging. Understand the properties of ultrasound and the operation of various ultrasonic methods, the principles of the formation of radionuclides. Define the standard of communication of medical images. Compare the principles of operation of a spectrophotometer, a clinical flame photometer, various analyzers of blood gases, various types of audiometers, surgical diathermy, hemodialysis, and various ventilators.	imaging systems Biomedical equipments Lasers and fiber optics in medicine Biosensors and smart sensors Biomedical digital signal processing		case study project	

	Justify the production of lasers, its properties and types. Evaluate the effect of laser tissue interaction. Formulate the characteristics of optical fibers and their application in medicine. Practice the principles of making fibers and bundles of fibers, the basic principle of endoscopy, its use in the diagnosis and therapeutic field. Compare device types, regulations and standards, and medical device approval process. Understand FDA (Food and Drug Administration) terms. Distinguish between components used for different biosensors and biosensor families. Apply biosensors in different areas of instrumentation, various types of photometric methods of analysis. Justify the process of checking the hardware and software of medical equipment. Use practical methods to remove the signal from the radiation detector; process analog and digital signals; experimentally determine noise levels; read and understand schematic diagrams. Independently understand the problems of modern nuclear radiation detection devices. Demonstrate the ability and willingness to use natural scientific knowledge in professional activities. Understand and establish professional tasks in research and practice. Apply advances in nuclear physics research in other areas of knowledge and, in particular, in radiation ecology. Use modern methods of processing experimental data, estimate errors in calculations and experiments. Use application packages for				

	processing experimental data. Select and use recording equipment for conducting nuclear physics experiments and environmental monitoring. Selection, design and design of detectors for all types of emissions. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results. Demonstrate ability by collecting, analyzing and systematizing experimental and theoretical data. Suggest methods of elementary systematics and to formulate the obtained regularities. Demonstrate acquired knowledge of visualization techniques in medical physics and bioengineering. Demonstrate an understanding of the overall structure and key elements of a CT course and its relationship with nuclear physics. Include new information obtained in the context of knowledge of nuclear physics and instrumentation, as well as quantitatively revise its content. Analyze a complex research situation and propose solutions to your problems using computational and visualization tools provided by the course. Apply methods of computational physics, numerical modeling, mathematical analysis, visualization tools, etc. in professional activities in various fields of nuclear physics and engineering. The specialist must have experience: using engineering methods to calculate protection from ionizing radiation sources; radiometric and spectrometric measurements; design of radiometric and spectrometric equipment for nuclear physics experiment and radioecological research; processing experimental data, evaluating experimental errors and calculating the characteristics of the				

	radiation source fields. Independently understand the problems of modern nuclear radiation detection devices. Encode information in multiparameter analyzers. Encode information from multiple detectors. Apply the correlation method in neutron spectrometry. Generate pseudo-random pulses. Conduct a multiparameter experiment. Justify the abbreviations of the NDT method. Determine the VT control tools. Identify the causes, prevention and repair of these welding discontinuities. Indicate welding target and NDE symbols. Describe the basic elements of welding and NDE symbols, measurement of welds. Explain the radioactive half-life. Describe the various types of RT equipment. Explain how radiation measuring instruments are used and types of measuring instruments are listed, how ultrasonic thickness gauges measure the thickness of a thickness, how ECT is performed. Independently understand the problems of modern medical devices. Understand and establish professional tasks in research and practice. Apply knowledge of technology, in particular, in experimental and theoretical research in the field of electronics and devices developing in medicine. Use the studied patterns to understand the processing of medical equipment. Formulate skills during presentations at scientific conferences and seminars on the physical understanding of the results obtained in the framework of the transition from classical physical to				

	quantum concepts. Demonstrate the ability to analyze and systematize the experimental and theoretical data in the field of medical instruments. Select suitable transducers for use in biosignal. Interpret various biological signals and conduct in-depth analysis. Develop systems for obtaining and measuring various physiological parameters.				
6. Practice	The purpose of the educational practice is to train students to solve physical problems and to work with scientific publications. The practice is aimed at developing group efforts in solving complex problems as well as at sharpening student's own understanding by taking part in discussions with other students.	Educational Practice	Practice	individual assignment for tasks	defense of report on practice
Practice Training	The purpose of the Institutional Practice is to fixing of theoretical knowledge of basic and major cycles of disciplines by practical, real performance by the student of duties of the expert, acquisition of practical skills and development of the best practices of professional and organizing work on a profile of future specialty. During the work practice, direct training of the student for professional activity in all directions in real working conditions is carried out. During an Institutional Practice data and information for the future bachelor degree project are collected. The students become familiar with technological, organizational and social aspects of the institution or company activity; they study and analyze specialized technical literature, software and other available information sources of the company. Pre-diploma practice of students is an important part of training and conducted in accordance with the basic specialty curriculum.	Institutional Practice 2 course Institutional Practice 3 course Institutional Practice 4 course	Practice	individual assignment for tasks	defense of report on practice

	The main purpose of the pre-diploma practice is to provide theoretical and practical results that are sufficient for the successful implementation and defence of the final qualifying work.				
7. Additional Types of Learning	Knowledge of state policy and fundamental achievements of the Republic of Kazakhstan in the field of physical culture and sports. Knowledge of the theoretical, methodological, hygienic and organizational foundations of physical culture and sports. The ability to use in practical life skills, ensuring the preservation and strengthening of health, development and improvement of psycho-physical abilities and qualities. Ownership experience in the use of means of physical culture and sport for disease prevention, mental well-being, development and improvement of qualities and personality traits.	Physical Education	classes	sports section	commissio ning standards

13. EDUCATIONAL PROGRAM IN ENGLISH “INSTRUMENT MAKING”
THE SPECIALTY 5B071600 - INSTRUMENT MAKING

Academic degree: The awarded degree: the bachelor of engineering and technologies on a specialty "5B071600 - Instrument making"

Name of modules	Discipline code	Names of disciplines (modules) and types of activities	Credit	ECTS	Lec.+Prac.+ Lab.	Sem.
1. GENERAL EDUCATION						
1. GE Compulsory Component (21 credits)		Modern History of Kazakhstan	3	5	2+1+0	1
		Philosophy	3	5	2+1+0	4
		Kazakh (Russian) Language	3	5	0+3+0	1
			3	5	0+3+0	2
		Foreign Language	3	5	0+3+0	1
			3	5	0+3+0	2
		Information-Communication Technologies	3	5	1+1+1	2
2. BASIC DISCIPLINES						
2. BD Compulsory Component (20 credits)		Mathematics 1	2	4	1+1+0	1
		Mathematics 2	3	5	1+2+0	2
		Physics 1	3	5	1+1+1	2
		Professional Kazakh (Russian) language	2	4	0+2+0	3
		Basics of electronics	3	5	1+1+1	3
		Physics 2	2	4	1+0+1	3
		Electrical Engineering	3	5	1+1+1	3

			Professionally-Oriented Foreign Language	2	4	0+2+0	4
3. MAJORS							
3. M Compulsory Component (5 credits)			Integraal and microprocessor circuitry	3	5	1+1+1	5
			Basics of Information and Measurement Technologies	2	4	1+0+1	5
4.Elective Course (7 credits GE; 49 credits BD)							
(8 credits)	**GE**		Computer science	3	5	1+2+0	1
	GE		Analytical geometry	2	4	1+1+0	1
	BD		Mechanics and molecular physics	3	5	1+1+1	1
(4 credits)	**GE**		Occupational Safety and Health	2	4	1+1+0	2
	BD		Chemistry	2	4	1+0+1	2
(9 credits)	**BD**		Atomic physics	3	5	1+1+1	3
	BD		Computer simulation	2	4	1+0+1	3
	BD		Probability theory	2	4	0+2+0	3
	BD		Basics of materials science	2	4	1+1+0	3
(13 credits)	**BD**		Circuitry of measuring devices	2	4	1+1+0	4
	BD		Basics of automation	2	4	1+1+0	4
	BD		Nuclear physics	4	6	1+1+2	4
	BD		Designing of devices on FPGA	3	5	1+0+2	4
	BD		Theory of measurements	2	4	1+1+0	4

(13 credits)	**BD**		Dosimetry and protection from radiation	3	5	1+1+1	5
	BD		Statistical processing and interpretation of nuclear physics experimental data	3	5	1+0+2	5
	BD		Detectors of nuclear radiation	4	6	1+1+2	5
	BD		Interaction of radiation with matter	3	5	1+1+1	5
(9 credits)	**BD**		Microcontrollers and their application	3	5	1+1+1	6
	BD		Spectrometry	3	5	1+0+2	6
	BD		Computer technologies in instrument making	3	5	1+1+1	6
5. Individual educational trajectories (IET) (27 credits)							
IET 1	**M**		Nuclear electronics	3	5	1+1+1	6
	M		Simulation of nuclear physics setups	3	5	1+1+1	6
	M		Instrument making in advanced nuclear physics experiments	3	5	1+2+0	6
	M		Basics of Python programming language	3	5	1+0+2	7
	M		Technology of designing devices and systems	3	5	1+0+2	7
	M		Computerized tomography methods	3	5	1+2+0	7
	M		Automation of acquiring data from coordinate-sensitive and track detectors	3	5	1+2+0	7
	M		Multiparameter and correlation measurements	3	5	1+2+0	7
	M		Devices for non-destructive testing	3	5	1+2+0	7

IET 2	**M**		Medical physics	3	5	1+2+0	6
	M		Medical instruments and medical engineering	3	5	1+0+2	6
	M		Clinical engineering	3	5	1+1+1	6
	M		Medical electronics	3	5	1+0+2	7
	M		Medical imaging systems	3	5	1+1+1	7
	M		Biomedical equipments	3	5	1+1+1	7
	M		Lasers and fiber optics in medicine	3	5	1+1+1	7
	M		Biosensors and smart sensors	3	5	1+1+1	7
	M		Biomedical digital signal processing	3	5	1+2+0	7
Total theoretical training 129 credits							
6. Practice		**Professional practice (by types of practice)**		**Credit**	**ECTS**	**Week**	**Sem.**
			Educational Practice	2	1	1	2
			Institutional Practice	1	2,5	2.5	4
			Institutional Practice	2	5,0	5	6
			Institutional Practice	2	5,0	7,5	8
			Pre-diploma Practice	4	7,5	5	8
7. Final Certification		8.1	Final examination	1			8
		8.2	Writing and Presentation of Diploma Thesis	2	4,5	4	8
8. Additional Types of Learning			Physical Education	8	8	(0+0+2)	1,2,3,4
Total 151 credits							

LEARNING UNITS OF SUBJECTS

1. GENERAL EDUCATION

THE MODERN HISTORY OF KAZAKHSTAN

Learning Units:

1. Socio-economic situation in Kazakhstan - preconditions struggle for independence.
2. The origins of the national movement of the Kazakh people.
3. The historical origins of the formation of the Soviet Kazakhstan: challenges of indigenization.
4. Formation of the Soviet totalitarian Kazakhstan: character, actions and consequences. The exploits and the loss of Kazakhstan in the fight against fascist aggression.
5. The contradictions and consequences of Soviet reforms in Kazakhstan in the second half of the XX century.
6. Apogee «cult of personality» and the influence of the «thaw» in the socio-political sphere. Socio-economic and spiritual «stagnation» Ecological problems of Kazakhstan. Attempts to "perestroika" Soviet Kazakhstan.
7. State strategy and socio-economic development of independent Kazakhstan. Formation of government of the Republic of Kazakhstan.
8. Kazakhstan model of economic development. Social reforms and changes in the field of education.
9. Ethnodemographic processes and strengthening of interethnic consent.
10. A democratic and spiritual renewal of independent Kazakhstan. Social and political prospects.
11. The youth policy in the Republic of Kazakhstan and define the path of spiritual renewal.
12. Policy formation of a new historical consciousness and outlook of the people of the Great Steppe.
13. The value of the Leader of the nation program "People in the stream of history" for the formation of a new historical consciousness.
14. The significance of the celebration of 550 anniversary of the Kazakh Khanate for the formation of a new social consciousness.
15. «Mangilik El» - Kazakhstan national idea of the XXI century. Kazakhstan - a country recognized by the modern world.

KAZAKH (RUSSIAN) LANGUAGE

Learning Units:

1. Introductory course: language and speech. The main functions of language.
2. Language and its basic functions. Speech: types and forms of speech. General characteristics of the forms and types of speech.

3. Text as the leading unit of verbal communication. The main features of the text. Methods of communication proposals in the text.
4. Functional-semantic types of speech. Understanding the types of monologue speech.
5. Functional styles of speech. General characteristics of functional speech styles.
6. Conversational style. Art style. Journalistic style. Official-business style.
7. Style and language features. The main genres of documentation. Preparation of documents: autobiography, resume, declarations, powers of attorney, receipts, reports and others.
8. Scientific style and its features. Stylistic features of scientific style. Lexical and grammatical means of scientific style.
9. Structural-semantic division of scientific text. Types of scientific information, incorporated in the text.
10. Definition: general characteristics. Introduction of the term.
11. Features more information text (summarizing, concretizing illustrating opening, the substitute).
12. Communicative situation scientific field of communication.
13. The culture of professional speech. Scientific discussion
14. Oral scientific speech
15. Convincing genres in scientific and journalistic style.

FOREIGN LANGUAGE

Learning Units:

1. Food: fuel or pleasure
2. If you really want to win, cheat.
3. We are family.
4. Revise and check.
5. Ka-ching.
6. Changing your life.
7. Intermediate control
8. Race to the sun.
9. Modern manners.
10. Judging by appearances.
11. If at first you don’t succeed,

12. Practical English: Renting a flat
13. Back to school, aged 35
14. In an ideal world
15. Intermediate control: revision

PHILOSOPHY

Learning Units:

1. The subject of philosophy. Subject matter, purpose and function of philosophy.
2. History of philosophy. The philosophy of the ancient world.
3. The philosophy of the Middle Ages of the East and the West
4. Renaissance Philosophy. The philosophy of the New Age
5. The philosophy of the European Enlightenment of the XVIII century. Classical German Philosophy.
6. The philosophy of the end of the eighteenth century - beginning of the XXI century.
7. Kazakh philosophy.
8. Basics of philosophical understanding of the world.
9. Being as the central category of ontology.
10. Development principle: dialectics and synergy.
11. Possibilities and boundaries of knowledge. The specificity of scientific knowledge.
12. Philosophy in the search and development.
13. Philosophical anthropology.
14. Social philosophy.
15. Philosophical understanding of today's global challenges.

INFORMATION AND COMMUNICATION TECHNOLOGIES

Learning Units:

1. The role of ICTs in key sectors of society. ICT Standards.
2. Introduction into computer systems. Architecture of computer systems.
3. Software. OS.
4. Human-computer interaction.

5. Database systems.
6. Data analysis. Data management.
7. Networks and Telecommunications.
8. Cyber security.
9. Internet technologies.
10. Cloud and Mobile technologies.
11. Multimedia technologies.
12. Smart technology.
13. E-technology. E-business. E-learning. E-government.
14. Information technology in the professional sphere. Industrial ICT.
15. ICT Development Prospects.

2. BASIC DISCIPLINES

MATHEMATICS 1

Learning Units:

1. Set. Operation over sets.
2. Definitions of a sequence. Limit of a sequence. Monotone sequences. Convergence of monotone sequences. The squeezing theorem for sequences. Some important limits. Number e.
3. Limits of the functions. Tangent lines and limits. One-sided limits. The relationship between one-sided limits and two-side limits. Infinite limits. End behavior of a function.
4. Continuity of a function. Classification of discontinuity points.
5. Cauchy criterion on existence of the limit of the function.
6. Continuity. Weierstrass's theorems
7. The Derivative. Tangent lines. Techniques of differentiation.
8. Rolle's and Lagrange's and Cauchy theorems. Indeterminate forms. L'Hopital's rule.
9. Taylor and Maclaurin polynomials.
10. Analysis of functions I: increase, decrease and concavity. Inflection points. Analysis of functions II: relative maxima and minima.

11. An overview of the area problem. Antiderivatives. The Indefinite integral. Integral curves.
12. Riemann sums and the Definite Integral.
13. The fundamental theorem of calculus.
14. Area between two curves. Arc length.
15. Volumes by washers perpendicular to x-axis.

MATHEMATICS 2

Learning Units:

1. Introduction. The first kind improper integrals.
2. The second kind improper integral.
3. Convergence and sums of numerical series.
4. Power series.
5. An orthonormal system in eucleadean space and Fourier series.
6. The Euclidean n-space. Functions of several variables.
7. Derivative and differentiability.
8. Higher order partial derivatives. Taylor's formula.
9. Extremal points of a function. Functions between.
10. Euclidean spaces, differentiating. Conditional extremum.
11. The double Riemann integral.
12. The triple Riemann integral.
13. Application of double and triple integrals in physics and mechanics.
14. The first kind curvilinear integral.
15. The second kind curvilinear integral.

PHYSICS 1

Learning Units:

1. Fundamentals of the theory of electromagnetic interactions.
2. Scalar potential. Description of electrostatic fields via scalar potentials

3. Electrostatic fields in dielectrics.
4. Mechanisms of dielectric polarization. Forces in an electric field
5. The main regularities of electrical current flowing through a conductor.
6. Electrical conductivity in solids.
7. Thermoelectric phenomena.
8. Electrical conductivity of semiconductors.
9. Electrical conductivity of gases. Plasma state of matter.
10. Constant magnetic fields.
11. Magnetic fields in magnetics.
12. Theory of magnetics.
13. Law of electromagnetic induction and its consequences.
14. Circuits of quasi-stationary alternating current and methods of calculations thereof.
15. Displacement current and Maxwell's equations.

PROFESSIONALLY-ORIENTED KAZAKH (RUSSIAN) LANGUAGE

Learning Units:

1. Introduction to the subject area on the professional Kazakh (Russian) language.
2. Foundations for mastery of subject-language material.
3. Basic categorical and conceptual apparatus in professional Kazakh (Russian) language.
4. Professional terminology in Kazakh (Russian) language.
5. Feature content domain majoring in Kazakh (Russian) language.
6. Mechanics terminology
7. Thermodynamics terminology
8. Electricity and magnetism terminology
9. Optics terminology
10. Electronics terminology
11. Atomic physics terminology
12. Nuclear physics terminology
13. Condensed matter physics terminology

14. Relativistic physics terminology
15. Quantum physics terminology

BASICS OF ELECTRONICS

Learning Units:

1. Introduction. The subject and content of the course. Electronic systems of transmission and release of information. Element base. Classification of electronic devices. Controlling the flow of charge carriers in a vacuum. Electrovacuum devices.
2. General information about semiconductors. Semiconductors from the standpoint of the zonal theory of solids. Charge carriers in a semiconductor. Carrier generation and recombination.
3. Electron-hole p-n junction in the absence of external voltage. Contact potential difference. Direct and reverse inclusion of p-n junction.
4. Semiconductor diodes. Classification of semiconductor diodes. Current-voltage characteristics of a real diode, differences from the characteristics of the ideal p-n junction, influence of external factors.
5. Bipolar transistors. The principle of operation of the bipolar transistor. Basic inclusion schemes. Equivalent circuit of an ideal transistor. Current-voltage characteristics of a bipolar transistor. Temperature drift characteristics of the transistor. Breakdown of transistor.
6. Field effect transistors. The principle of operation of the field-effect transistor with the control p-n junction. Current-voltage characteristics, basic parameters and equivalent circuit. Basic inclusion schemes. The effect of temperature on the characteristics.
7. Photoelectronic and optoelectronic semiconductor devices. Photoresistive effect. Photoresistors. Photovoltaic effect. Photodiodes. Photocells. Phototransistors, photo thyristors.
8. Elements and principles of the construction of semiconductor integrated circuits. Features of integrated circuits (IC) as a new type of electronic devices. Basic concepts and definitions. IC classification.
9. Basic information about amplifiers. Classification amplifiers. The main characteristics and parameters of amplifiers: gain, amplitude, amplitude-frequency, phase-frequency and transient characteristics of the amplifier.
10. Amplification cascades on bipolar and field-effect transistors. Schemes to ensure the static mode of active elements. Schematic diagram of the cascade with a common emitter.
11. Powerful amplifier stages. Modes of operation. Single - and push-pull amplifiers for bipolar and field-effect transistors.
12. Generating harmonic vibrations. Generator as an amplifier covered by positive feedback. Generalized block diagram of the harmonic oscillator. The condition of oscillation. Stationary generator mode, phase and amplitude balance.

13. Impulse devices. Multivibrators. Self-oscillating and waiting multivibrators. Blocking generators. Generators sawtooth voltage.
14. Digital presentation of information. The algebra of logic. Logical functions. Electronic keys. Principles of construction of logical elements.
15. Secondary power supplies of electronic devices. The general block diagram of the secondary power source. Convert variable voltage to permanent. Rectifier circuits. Surge Protectors.

PHYSICS 2

Learning Units:

1. Energy and light quantities and units.
2. The phenomenon of refraction.
3. Centered optical system.
4. Eye and vision**.**
5. Interference of light.
6. The phenomenon of diffraction.
7. Diffraction and spectral analysis.
8. The concepts of polarization in optics.
9. Polarization phenomena.
10. Anisotropic media. Fundamentals of crystal optics.
11. The scattering of light.
12. Thermal radiation.
13. Planck's formula.
14. Synchrotron radiation.
15. Photoelectric effect.

ELECTRICAL ENGINEERING

Learning Units:

1. Introduction. The subject and objectives of the discipline. Electrical circuit. Components of electrical circuits. Sources of electrical energy and consumers. Transmission of electrical energy from source to consumer.

2. General concepts and definitions of linear electric circuits. Electric current and current density. Voltage. Electromotive force. Power. Energy.
3. Sources of electrical energy. Bipolar networks. Ways to connect consumers. The laws of the electric circuit DC.
4. Application of Kirchhoff's laws for the calculation of DC circuits. The principle of superposition. Nodal tension method.
5. Method of contour currents. Equivalent transform methods. Plotting potential diagrams.
6. Nonlinear DC circuits. Graphic calculation method. Analytical method of calculation.
7. Single-phase sinusoidal current. Basic definitions. Current and average value of alternating current. Symbolic calculation method. The method of vector diagrams.
8. Single-phase alternating current. Resistor, capacitor and inductance in the AC circuit. Active and reactive resistances.
9. Branched and not branched single-phase AC circuits. Triangle resistors and conductances. The relationship between resistance and conductive.
10. AC power circuit. Power balance. Power factor. Methods for increasing power factor.
11. Resonance phenomena in AC circuits. Resonance voltage. Resonance currents. Frequency characteristics.
12. Magnetic circuits of alternating current. Inductively coupled circuit. Transformers.
13. Three-phase AC circuits. Basic definitions. Connection of 3 phase circuits by a star and a triangle.
14. Rectification of alternating current. Straightening schemes. Straightening with voltage multiplication.
15. Electric cars. Generators and DC motors. Generators and AC motors.

PROFESSIONALLY-ORIENTED FOREIGN LANGUAGE

Learning Units:

1. What is Physics
2. Units of measurement.
3. The states of matter
4. Atom. The structure of atom.
5. The shape and structure of the atomic nuclei.
6. The discovery of radioactivity.
7. Matter and antimatter
8. Nuclear models
9. Nuclear energy.

10. Energy from the Sun.
11. Origin of the elements
12. Superconductivity
13. The Universe and the Solar system
14. Big Bang
15. Particles that go faster than light.

3. MAJORS
INTEGRAL AND MICROPROCESSOR CIRCUITRY
Learning Units:

1. Introduction. Logical functions and logical elements. The concept of a logical variable. Logical element and logical device. Input and output logic variables, logic functions. Tabular and analytical way to set a logical function.
2. The concept of a series of microcircuits. Logic chips for the implementation of basic logic functions, their conventional graphic notation and electrical parameters
3. Axioms of the algebra of logic, laws of the algebra of logic. Implications of them and practical use. The concept of the minimum form of a logical function.
4. Combination logic devices. The main types of combinational logic devices are encoders, de-encoders, code converters, adders, multiplexers, comparators.
5. Sequential logic circuits. Triggers, registers, counters. Synthesis of complex devices based on them.
6. Storage devices. Basic structures of memory devices. Types of storage devices, their classification: permanent and operational memory.
7. Static and dynamic memory, once programmed and repeatedly reprogrammable memory with ultraviolet and electric erasure.
8. The use of memory chips for the implementation of multi-output complex combinational logic devices.
9. Microprocessor architecture. The concept of architecture: the width of addresses and data, formats for data representation, command system, interrupt system.
10. The structure of the microprocessor and its main components: central processing unit (CPU), read-only memory (ROM), random access memory (RAM), input / output devices (IOD), and object communication devices (ODS).
11. Software microprocessors. Programming languages of microprocessors: assemblers and machine command codes, command formats; possibilities of using algoritmic languages and SCADA systems.

12. Organization of communication between nodes: bus system, their classification, rules of operation, interfaces. Conveying, data processing and speed.
13. Programming I / O ports, timers; interrupt handling programs; programming cycles and branching, arithmetic and logical operations.
14. Microprocessor systems. Structure of microprocessor systems. Ways of interfacing microprocessors between themselves.
15. Methods of automation of circuit design of electronic nodes. Software packages design electronic circuits.

BASICS OF INFORMATION AND MEASUREMENT TECHNOLOGIES

Learning Units:

1. Functional tasks of information-measurement systems.
2. Quantitative evaluation of measurement information.
3. Signals, their mathematical models and transformations.
4. Methods of measurement data' analysis.
5. Statistical data processing.
6. Statistical evaluation of random processes' characteristics.
7. Measuring systems converters.
8. Analog interfaces.
9. Analog-to-digital and digital-to-analog converters.
10. Digital interfaces.
11. Transmission of measurement data in systems channels.
12. Coding of measurement information.
13. Encryption and decryption of measuring information.
14. Protection of measurement data from unauthorized access.
15. Metrological provision of systems.

4. ELECTIVE COURSES (MAJORS)

4.1. GENERAL EDUCATION
COMPUTER SCIENCE
Learning Units:

1. Beginning with c++. a) What is C++, its Applications, Advantages etc. b) Difference between C and C++. major and minor difference. c) Creating C++ source file, Editing, Compiling, Linking, Debugging. Etc. d) Make File Utility, Command Line Arguments etc.
2. Explaining Procedure oriented Language(C) and Object Oriented Language.(C++). a) Look at Procedure-oriented Programming b) A Brief Look At Object Oriented Programming(OOP). c) Applications of OOP, Benefits of OOP
3. Functions In C++. a) Different forms of functions b) function prototyping c) Call by Reference d) Inline Functions e) function overloading f) friend and virtual functions g) Math library functions etc
4. Classes And Objects. a) C Structure revision b) defining classes, defining member functions. c) declaration of objects to class d) access to member variables from objects etc e) different forms of member functions dependence on access specifiers(i.e. Private, public, protected) . e) array of objects f) objects as function arguments h) friendly function i) returning objects j) pointers to members h) local classes.
5. Memory Management and pointers. a) Using New operator, comparison of new over malloc, calloc and realloc etc. b) Memory freeing using Delete operator.
6. Constructor and Distributor. a) intro b) constructors, c) parametrized constructors d) Multiple constructors in class e)dynamic initialization of objects f) Destructors.
7. Operator Overloading and type conversion. a) intro b) defining operator overloading c)overloading - (unary, binary operators) d)overloading binary operators using friends e) Rules for overloading operators f)type conversion
8. Inheritance – extending class. a) Intro b) types of inheritance c) single inheritance d) multiple inheritance e) Multilevel inheritance f)hierarchical inheritance g)hybrid inheritance etc. f)virtual base class g) abstract class h) constructors in derived class.
9. Pointer, Virtual Functions, Polymorphism. a) intro b)pointers c) pointers to objects d) this pointer e) pointers to derived class f) virtual functions g) pure virtual functions etc.
10. Managing Console I/O Operations. a) intro b)C++ streams c) c++ stream classes d) unformated / formated I/O operations. e) managing output with manipulators.

11. Working with files. a) intro b) creating/ opening / closing / deleting giles c) file pointers and their manipulators d)updating file random access to file e) Error handling during file operations. f) command line arguments.
12. Introducing STL (Standard template library). a) intro b) components of STL c) containers d) algorithms e) iterators f) function objects
13. String Manipulation in C++. a)intro b) creating objects c) manipulating string objects d) relational operators e)string characters f) accessing characters in strings.
14. New Features of C++. a) new data types, b) new operators c) class implementation d) namespace scope e) operator keywords f) new headers etc.
15. Object oriented system development.

ANALYTICAL GEOMETRY

Learning Units:

1. Coordinate systems. Vectors. Vector spaces
2. Subspaces, span, and basis
3. Products of vectors
4. Linear transformations
5. Straight lines and curves on the plane
6. Surfaces in space
7. Alternative coordinate systems
8. Matrix theory. Matrix multiplication
9. Systems of linear equations. Cramer's Rule
10. Transformations of the plane
11. Linear Operators
12. Eigenvectors and eigenvalues
13. Second-order curves in the plane
14. Second-order surfaces
15. Applied problems of analytical geometry and linear algebra

OCCUPATIONAL SAFETY AND HEALTH

Learning Units:

1. Introduction.
2. Emergency situations of civil and military time.
3. Weapons of Mass Destruction.
4. Act of terrorism.
5. Natural danger. Earthquakes.
6. Natural danger. Selenium, flood, avalanches, etc.
7. Biomedical hazards. Dangerous diseases of the XXI century - drug addiction, STI, HIV / AIDS, tuberculosis, etc.
8. Social hazards. Religious sects. Their danger.
9. Technogenic hazards. Radiation. Ionizing radiation. Radiation-hazardous objects.
10. Non-ionizing radiation (EMF, Laser.I, UZ).
11. Security measures when working with a computer. Cell Phone Security.
12. Chemical danger. Chemically dangerous objects.
13. Fires and explosions at work and at home, origin, consequences.
14. Protection of the population and territories in emergency situations.
15. Fundamentals of organizing and conducting rescue and other urgent work.

4.2. BASIC DISCIPLINES

MECHANICS AND MOLECULAR PHYSICS

Learning Units:

1. Introduction. Powers of ten. Evaluation of physics quantities.
2. Kinematics of a particle. Newton's Laws.
3. The system of particles. Work and Energy.
4. Collisions. Motion due to gravity.
5. Non-inertial frames of reference. Dynamics of a rigid body. Gyro.
6. Mechanics of the solid medium. Harmonic oscillations. Oscillations and waves.
7. The foundations of the special relativity. Relativistic dynamics.

8. Object of molecular physics. Model of ideal gas.
9. Statistical method. Basic concept of mathematical statistics.
10. Ergodic hypothesis. Fluctuation. Microstate and macro state.
11. Maxwell velocity distribution. Temperature.
12. Barometric height formula. Maxwell-Boltzmann distribution. First law of thermodynamics.
13. Second law of thermodynamics. Third law of thermodynamics. Transport phenomena.
14. Real gases. Liquids.
15. Solids. Phase transitions.

CHEMISTRY

Learning Units:

1. The main classes of inorganic compounds. Classification of inorganic hydroxides.
2. Main stoichiometric laws of chemistry. Gas laws. Avogadro's Law. The law of equivalents.
3. The structure of the atom. The concept of quantum numbers. The shape and orientation of the electron orbitals. Communication of the periodic system with the structure of the atom.
4. Types of chemical bonds, their characteristics.
5. Chemical kinetics. Factors affecting the rate of chemical reactions.
6. Chemical equilibrium. Le Chatelier's Principle.
7. Solution. Ways of expression of concentration of solutions.
8. Oxidation and Reduction reactions.
9. Electrolytic dissociation. Law of dilution. Chemical reactions between the electrolytes. Ionic equation.
10. The acid-base equilibrium in aqueous solution: dissociation of water, the pH value, buffers, hydrolysis of salts.
11. Radioactivity.
12. Main group metals and their properties.
13. Metals of secondary subgroups and their properties.
14. General properties of non-metals.
15. General properties of non-metals.

ATOMIC PHYSICS

Learning Units:

1. Introduction. Atoms and molecules. Specification of the processes in the micro world. Atomic spectra and Ritz combination principle. Atomic models.
2. Bohr's quantum model of the atom.
3. The Compton effect. De Broglie waves. Wave-particle duality. Photoelectric effect.
4. Wave function. The Uncertainty Principle. The Schrödinger equation. Particle in a rigid box.
5. The solution of the quantum-mechanical problem for hydrogen atom.
6. Energy levels of alkali atoms. Quantum defect. Multi-electron atoms. Electron configurations.
7. Spin–orbit interaction. The fine structure of the spectral lines of hydrogen atoms and atoms of alkaline metals.
8. Pauli exclusion principle. Approximate description of electrons by individual quantum numbers. The concept of electronic configuration. Vector addition of angular momentum. Types of bonds.
9. General characteristics of the spectra of multi-electron atoms. The application of the Pauli exclusion principle. Energy levels and spectrum of atom He. Term symbol.
10. Electron shells. Explanation of the periodic table of elements. Electron shell.
11. Continuous and characteristic x-ray spectra. Moseley's law. X-ray series. Fine structure of the x-ray lines.
12. Covalent and ionic bonds in molecules. Hydrogen ion and hydrogen molecule. Valence. Valence bonds method.
13. Types of motion in the molecule. Orders of magnitude of the electronic, vibrational and rotational energies. Vibration and rotation of diatomic molecules. Rotational, vibrational and electronic spectra of molecules. Diatomic molecules.
14. Zeeman effect. Stark effect.
15. Absorption, spontaneous and stimulated emission. Einstein coefficients. Lasers. Boltzmann distribution and thermal equilibrium.

COMPUTER SIMULATION

Learning Units:

1. C ++ programming language. Algorithms, variables and basic structures. C++ Variable Types. The basic arithmetic operations. C++ Constants definition. Trigonometric, exponential, and other special functions in C ++. C++ libraries.
2. Numerical methods for ordinary differential equations. Newton's Differential Equations of Motion. Body thrown at an angle to the floor and bouncing from the containment walls. Ball rolling down on a rigid staircase.

3. Verlet algorithm and conservations laws in Newton’s dynamics. Picard iterative process. Modified Euler’s method. Euler-Cromer algorithm.
4. Scalars, vectors, matrices and multidimensional arrays in C ++. Formatting data and writing it to a file for further processing and visualization. Predictor-corrector method. Leap-frog method.
5. Nonlinear differential equations. Stability of numerical solution. Loops in C ++. Using loops to calculate sums and products of the number series. User defined functions to calculate factorial, polynomial and other special function.
6. Numerical methods for ordinary differential equations. Types of equations that could be reduced to the system of differential equations. Selection statements: if, else, switch. Jump statements: break, continue and go to. Writing data recursively to hard drive for further processing by other programs.
7. Numerical integration. Trapezoidal, rectangles and Simpson's rule, etc. Charged particle motion in the crossed electric and magnetic fields. Kepler's laws. The Fourth Order Runge Kutta Method.
8. Simple and physical pendulums. Rotations and revolving motion. Differential equation describing the current change in a series RLC circuit. Rutherford scattering.
9. Coulomb interaction between two free charges. Scattering of the non-interacting beam of particles by the massive charge.
10. Simulating interaction between the multiple particles in a confined space. Periodic boundary conditions. Ideal gas in 3-dimensional space.
11. Interpolation and extrapolation. Newton interpolation polynomial. Lagrange interpolation polynomial.
12. Fourier series. Fourier transform. Fourier series of some special functions. Complex Form of the Fourier Series.
13. Random numbers. Pseudorandom number generators. Area Estimates by Monte Carlo Simulation. A numerical calculation of multidimensional integrals.
14. Numerical solution to the Schrödinger equation. Variational Principle method. Partial Differential Equations.
15. Poisson equation. Teacher supervised training: Laplace equation.

PROBABILITIES THEORY

Learning Units:

1. Subject of Probability Theory.
2. Events and Operations over Events.

3. Definitions of Probability.
4. Additive Rule. Conditional Probability. Product Rule.
5. Independence of Events. Bayes' Formulas.
6. Bernoulli' scheme. Polynomial scheme.
7. Asymptotic Formulas of Bernoulli' scheme.
8. Random Variable (finite case). Distribution Law.
9. Distribution Function. Operations over Random Variables.
10. Numerical Characteristics of Random Variables.
11. Random Variable (general case).
12. Large Numbers Law. Central Limit Theorem.
13. Population and Sample.
14. Point Estimators of Parameters and its Basic Properties.
15. Confidence Intervals. Statistical Hypothesis Testing Scheme.

BASICS OF MATERIALS SCIENCE

Learning Units:

1. Introduction. The most important events preceding the becoming of materials science as a science. Definitions and directions of research in materials science. Scientific surveys, which became the basis of materials science. The role of materials in science and technology.
2. Primary information about the material world and materials science. Macro and microworld. Physical units in the macro and microworld. The speed of the processes in the macro and microworld. Universal constants in the macro and microworld.
3. The atomic nucleus. Nuclear mass defect. The relative sizes of the atom and nucleus. The density of the nuclear mass. The strength of the core. The structure of the electron shell of an atom
4. Classification of the chemical elements. Three levels of periodicity of elements.
5. Basic information from the theory of alloys - solid solution, mechanical mixture, chemical compound. Phases and state diagrams. The real structure of metals, properties and methods of their testing.
6. The structure and properties of iron. The state diagram of the iron-carbon system alloys. The structure and properties of iron-carbon alloys.
7. Construction materials of nuclear power plants. Specific requirements for reactor materials. Materials of the reactor core.

8. The technology of obtaining powder materials. Constructional powder materials. Friction and anti-friction powder materials.
9. Sintered steel. Sintered non-ferrous metals. Electrotechnical powder materials. Magnetic powder materials.
10. Composite materials. Matrix and reinforcement. Classification of composite materials. Composite materials with zero-dimensional fillers.
11. Composite materials with one-dimensional fillers. Filamentous fillers. Eutectic and polymeric composite materials.
12. Amorphous materials. Methods for obtaining. Areas of use.
13. Ceramic materials. Structure. Requirements to the starting materials for the synthesis of special ceramics. The main types of materials used for the synthesis of ceramics. Methods of synthesis of ceramic materials.
14. Nanomaterials and methods for their processing. Nanotechnology and the development of the life sciences. The possibility of using nanotechnology and consequences
15. Physico-chemical properties of the materials - mechanical, thermal, electrical, chemical and optical properties.

CIRCUITRY OF MEASURING DEVICES

Learning Units:

1. Introduction. Measurement of physical quantities. Basic concepts and definitions. Properties of measuring instruments and requirements for them.
2. Measuring transducers, classification, basic parameters. Measuring circuits of generator measuring converters.
3. Measuring circuits of parametric converters: a chain of series connection, a chain in the form of a divider, non-equilibrium bridges.
4. Operational Amplifiers (OA). Basic OC switching schemes: inverting, non-inverting, differential amplifiers.
5. Functional converters. Multiplier and divider signals. Perform special operations on signals.
6. Determination of the average absolute value (measuring rectifiers). Phase-sensitive rectifiers (demodulators).
7. Theoretical foundations of analog-digital and digital-analog conversion. The main parameters of analog-to-digital converters (ADC). ADC classification.
8. Serial ADC with step voltage generator. ADC sequential approximation. ADC with time - pulse conversion.
9. ADC with two-stage integration. Parallel ADC.
10. Voltage - frequency converters. Digital to Analog Converters (DAC).
11. Digital and analog-digital measuring channels.
12. Digital methods for measuring time intervals.

13. Digital methods of frequency measurement.
14. Information display devices.

BASICS OF AUTOMATION
Learning Units:
1. Impulse devices. Parameters and characteristics of the pulse and transient signals. Linear elements for the pulse regime devises. RC an RL circuits. Transistor switches.
2. Switches. Symmetric and asymmetric. Switching circuitries.
3. Blocking oscillators. The generator of linearly varying voltage. The stabilizing generator of linearly varying voltage
4. Comparator instrument. Discriminators for the selectors for pulse signals.
5. Fundamentals of Discrete Automation. Boolean and other logical functions. Truth Tables for the Laws of Boolean and their application.
6. MOSFET gate. Constructing complex logical gates and devices.
7. Synthesis of combinational devices on logical elements. Synthesis of incompletely specified logical functions. Synthesis of Logic Devices with Multiple Outputs.
8. Digital devices. Number systems. Performing arithmetic operations. Integrated logic circuit.
9. Encoders, decoders, code converters. Multiplexing and demultiplexing switches. Programmable Logical Matrix of elements.
10. Addressing register. Electronic counters.
11. Adders. Analog-to-digital converters. Electronic storage gates and circuits.
12. Digital circuitry control devices. Digital circuitry control devices schematics and design software.
13. Computers. Basic architecture and operation principles. Linear and parallel computations paradigms.
14. CPUs and their architectures. Input-Output interfaces and devices.
15. External storage devices. Microcontrollers. Programable microcontrollers.

NUCLEAR PHYSICS
Learning Units:
1. The subject and structure of the course. The subject of discipline, its relationship with other specialty disciplines.
2. Physics of composition, structure and dynamics of nuclei.

3. Intranuclear forces of interaction.
4. Nuclear models. Single-particle models.
5. The collective models.
6. The cluster models.
7. Physics of nuclear reactions.
8. Classification of nuclear reactions by the type of incident and emitted particles.
9. Fission and fusion of atomic nuclei.
10. The physics of radioactive decay. Radioactivity and types of ionizing radiation. Alpha decay.
11. Beta decay. Gamma radiation of nuclei.
12. Interaction of nuclear radiations with matter.
13. Elementary particles.
14. Cosmic rays.
15. Applied Nuclear Physics.

DESIGNING OF DEVICES ON FPGA

Learning Units:

1. Design and calculation of simple logic circuits.
2. Combination and successive FPGA devices.
3. Design of digital devices and digital control.
4. Development of memory modules.
5. Counters.
6. Frequency divider.
7. Simulation of the combination circuit.
8. Simulation of data flow.
9. Multiplexer and demultiplexer.
10. Serial Detector.
11. The machine with final states.
12. Memory RAM.
13. Module memory.

14. Memory Recording.
15. Complex digital signals in FPGAs.

THEORY OF MEASUREMENTS

Learning Units:

1. Introduction. Subject and tasks of the discipline. Measurement is a quantitative characteristic of the surrounding material world.
2. Theoretical basis of measurements. Objects of measurements. Basic concepts. Measured values.
3. Basic concepts of the general theory of measurement. Physical quantities. Classification of physical quantities.
4. The basic equation of measurements. Measuring transformation. Axioms of measurement theory. Classification of measurements.
5. Units, dimensions and systems of physical quantities. The international system of units, the principles of building systems of units of physical quantities.
6. Theory of the reproduction of units of physical quantities and transfer of their sizes (theory of the unity of measurements).
7. Basic concepts of the theory of errors. Classification of errors. Principles of error estimation. Mathematical models of errors. Basic (primary) concepts of probability theory, used to analyze the accuracy of processing and control.
8. The Gaussian distribution law. Basics of statistical analysis of measurement results. Construction of histograms and distribution polygons. Estimates of the numerical characteristics of random variables.
9.Production of measurement results. Direct multiple measurements. Equal measurement. Pearson's criterion, compound criterion. Single measurements. Indirect measurements. Joint and cumulative measurements.
10. Criteria for assessing misses. Evaluation of the accuracy of processing using the distribution curves.
11. Original terms and definitions. Means of measurement. Classification of measuring instruments. Methods of measurement.
12. Structural elements of SI. SI parameters and devices. Errors of SI. Classes of accuracy of SI. Metrological characteristics of SI. Normalization of metrological characteristics of SI. Metrological reliability of SI. Operating modes SI. Methods for transferring the size of a unit of physical quantity.
13. Measurement and control of mechanical quantities. Methods and means of measuring and controlling the mechanical properties of substances and materials. Measurement and control of thermal quantities. Methods and means of measuring and controlling the thermophysical properties of substances and materials.

14. Measurement and control of electrical and magnetic quantities. Methods and means for measuring and controlling the flow and quantity of gases and liquids.
15. Measures to ensure the uniformity of measurements. State testing and verification of measuring and control equipment. Metrological audit and metrological examination.

DOSIMETRY AND PROTECTION FROM RADIATION
Learning Units:
1. The tasks of dosimetry and protection from ionizing radiation.
2. The law of radioactive decay. Activity of radionuclides. Units of measure of activity.
3. The interaction of charged particles with a biological substance. Ionization losses. Elastic and inelastic scattering. Nuclear reactions.
4. Brake and characteristic X-ray radiation. The processes of interaction of gamma quanta with matter.
5. The law of attenuation of X-ray and gamma-radiation. The total coefficient of attenuation of gamma quanta.
6. Classification of neutrons. Elastic neutron scattering. Recoil nucleus. Radiation capture. Nuclear reactions.
7. Methods for recording ionizing radiation. Dosimeters.
8. Units of radiation dose. Absorbed, equivalent, effective doses.
9. Methods for calculating the protection from gamma radiation
10. Methods for calculating the protection against electrons.
11. Methods for calculating protection from heavy charged particles.
12. Methods for calculating protection against neutron radiation.
13. Radiation doses for radiation diagnosis.
14. Radiation doses for radionuclide diagnostics
15. Highlights and extracts from the reports of the International Commission on Radiation Protection.

STATISTICAL ANALYSIS AND INTERPRETATION OF NUCLEAR PHYSICS EXPERIMENTS DATA
Learning Units:
1. Introduction of the problem, examples of statistical analysis.
2. Statistical distributions, histograms.
3. Maximum likelihood method, chi-square distribution, fitting.

4. Frequentists and Bayesian approaches.
5. Introduction in CERN ROOT.
6. Reading, writing and plotting in ROOT.
7. One-dimensional and multidimensional functions and distributions in ROOT, ROOT profiles.
8. Fitting in ROOT, introduction in RooFit.
9. ROOT: fitting histograms and distributions.
10. ROOT: fitting one-dimensional and multidimensional functions.
11. Application of ROOT in particle physics: fitting particle cross-sections, finding resonances.
12. Quality cuts in parameters and phase space.
13. Iintroduction in multivariate analysis, TMVA.
14. Examples in TMVA.
15. ROOT containers and trees.

DETECTORS OF NUCLEAR RADIATION

Learning Units:

1. Classification of Detector.
2. Ionization Chambers. Pulse Chambers.
3. Gas-Filled Pulse Counter.
4. Variation of Pulse Sizes.
5. Proportional Counter. Construction.
6. Geiger Muller Counter. Construction and Characteristics.
7. Pulse Formation and Decay. Scaling Circuits. Resolving Time.
8. Determination of Resolving Time: Double Source Method.
9. Semi-conductor Particle Detectors. Reversed Biased p-n Junction Particle Detector. Advantage. Disadvantages.
10. Neutron Detectors. Principle.
11. Slow Neutron Detectors.
12. Boron Detectors. BF3 (Boron-Trifluoride) Proportional Counters.
13. Fission Detectors. Fast Neutron Detectors.
14. Scintillation Counter. Construction.

15. Gamma Ray Spectroscopy with NaI (TL) Scintillator.

INTERACTION OF RADIATION WITH MATTER

Learning Units:

1. Basic concepts and definitions of the interaction of ionizing radiation with matter.
2. The law of radioactive decay. Activity of radionuclides. Units of measure of activity.
3. Interaction of electrons with matter. Ionization losses. Elastic and inelastic scattering.
4. Interaction of heavy charged particles with matter. Protons, alpha particles, heavy ions. Ionization losses. Elastic and inelastic scattering.
5. Interaction of heavy charged particles with matter. Ionization losses, radiation losses. Elastic and inelastic scattering.
6. Transmission of gamma radiation through matter. Brake and characteristic X-ray radiation. The processes of interaction of gamma quanta with matter. Photoelectric Absorption. Thomson Scattering. The Compton effect.
7. Transmission of gamma radiation through matter. The law of attenuation of X-ray and gamma-radiation. The total coefficient of attenuation of gamma quanta.
8. Transmission of neutrons through matter. Classification of neutrons. Elastic and inelastic neutron scattering. Recoil nucleus.
9. Transmission of neutrons through matter. Radiation capture. Nuclear reactions. Fission by neutrons of different energies.
10. Methods and devices for recording ionizing radiation. Scintillation method. Photographic method. Calorimetric methods. Chemical methods.
11. Methods and devices for recording ionizing radiation. Methods for recording neutrons.
12. Dosimetry of ionizing radiation. Basic concepts and definitions of doses.
13. Hygienic standards and sanitary regulations of the Republic of Kazakhstan.
14. Methods of calculation of protection against gamma radiation, from alpha, beta particles, from heavy ions, from neutron radiation.
15. Methods for calculating protection against neutron radiation.

MICROCONTROLLERS AND THEIR APPLICATION

Learning Units:

1. Introduction. General principles of microprocessor systems (MPS).
2. Microprocessor (MP). Classification and structure of MP. The principle of operation of the MP.

3. The simplest 8-bit universal microprocessors. Intel 8080
4. 6-bit universal microprocessors. Intel 8086. Intel 80286.
5. 32-bit universal microprocessors. Intel 80386. Intel 80486.Pentium.
6. Architecture of the IPU. The main functions of the IPU. Write, read, interrupt and direct memory access.
7. The hierarchical organization of the memory of the IPU. The main types of storage devices.
8. Building a module of the central processor based on the i8086 and the connection diagram of the RAM and ROM. Buffer register. Tire shapers.
9. Input and output interfaces. Data exchange in the IPU. I / O methods and their classification. Serial data transfer.
10. Single-chip microcontrollers (MK) with CISC architecture. Architecture single-chip MK. Microcontrollers MCS-51.
11. Single-chip MK with RISC architecture. PIC controllers. Structure and command system.
12. The AVR microcontroller. Structure and command system.
13. Signal processors.
14. Neural processors. The structure of neural processors and its principle of operation.
15. Specialized processors. Communication and network processors. Transputers.

SPECTROMETRY

Learning Units:

1. Introduction - basic definitions and historical review
2. Ionization energy losses. Radiation loss of energy. Scattering of particles.
3. Interaction of charged particles with matter and their detection
4. Interaction of photons with matter, detection of X and gamma rays
5. Ionization chambers. Pulsed ionization chambers. Proportional counters. Counters with an independent discharge.
6. Nuclear emulsion. Spark camera. Multiwire detectors.
7. Scintillation and semiconductor detectors and spectrometers, analysis of obtained spectra
8. Semiconductor detectors and spectrometers, analysis of obtained spectra
9. Selected applications of gamma spectrometry, life time measurement, on beam spectrometry, angular correlations
10. Different types of detectors, magnetic and electrostatic spectrometers.
11. Selected applications of low and high energy charged particle spectrometry
12. Interaction of neutrons with matter and their detection

13. Neutron spectrometry and its applications
14. Interaction of neutrino with matter, their detection and spectrometry
15. Decoding of instrumental spectra.

COMPUTER TECHNOLOGIES IN INSTRUMENT MAKING

Learning Units:

1. Matlab integrated development environment. Basic variables and structures. Trigonometric, exponential, and other special functions in Matlab. Definitions, precision and usage. The basic operations and operators.
2. Visualizing Newton's differential equations of motion. Implemented ODEs solvers in Matlab. Body thrown at an angle to the floor and bouncing from the containment walls. Ball rolling down on a rigid staircase.
3. Conservations laws in Newton's dynamics. Picard iterative process. Explicit symbolic integration in Matlab. Demonstrate stability and convergence of the modified Euler's method and Euler-Cromer algorithm.
4. Scalars, vectors, matrices and multidimensional arrays in Matlab. Memory usage and allocation. Predictor-corrector method and Leap-frog method graphical implementation. 2D and 3D plotting.
5. Nonlinear differential equations. Stability of numerical solution. Estimate boundary conditions from the graphics. Loops in Matlab. Using loops to calculate sums and products of the number series. Overloaded user defined functions to calculate factorial, polynomial and other special function.
6. Simulating Motion in 3D. Types of equations that could be reduced to the system of differential equations. 6. Matlab selection statements: if, else, switch. Jump statements: break, continue and go to.
7. Visualize trapezoidal, rectangles and Simpson's rule, etc. Mapping electric and magnetic field configurations. Charged particle motion in the crossed electric and magnetic fields. Build the Solar system model. Kepler's laws using The Fourth Order Runge Kutta Method.
8. Construct numerical models of the simple and physical pendulums. Study rotations and revolving motion of the complex objects. RLC circuit current, charge and voltage diagrams.
9. Rutherford scattering in the Lab system. Test the limit of the non-interacting beam of particles model. Coulomb interaction between two free charges. Scattering of the non-interacting beam of particles by the massive charge.

10. Simulating interaction between the multiple particles in a confined space. Periodic boundary conditions. Ideal gas in 3-dimensional space. Interpolation and extrapolation.
11. Build and test Newton interpolation polynomial for an arbitrary function. Build and test Lagrange interpolation polynomial for an arbitrary function. Fourier series. Fourier transform.
12. Fourier Spatial filters. Low and High Pass filters. Random numbers. Pseudorandom number generators.
13. Area Estimates by Monte Carlo Simulation. A numerical calculation of the multidimensional integrals.
14. Numerical solution to the Schrödinger equation. Variational Principle method. Application of the Variational Principle method.
15. Partial Differential Equations. Poisson equation. Laplace equation. Relaxation method.

5. INDIVIDUAL EDUCATIONAL TRAJECTORIES

NUCLEAR ELECTRONICS

Learning Units:

1. Classification of Detector.
2. The basic scheme of the inclusion of radiation detectors.
3. Harmonization of schemes for the inclusion of radiation detectors with electronic devices.
4. Photoelectric multipliers in scintillation counters.
5. Shortening of signals.
6. Signal Strengthening.
7. Noise and filtering of signals.
8. Overloading the amplifiers and restoring the DC component.
9. Overlapping.
10. Linear transmission of signals.
11. Discrimination of signals in form.
12. Logical elements.
13. Memorizing elements (triggers).
14. Counters (scaling circuits) on integrated circuits.
15. Transformation of digital information. Memory devices (storage).

SIMULATION OF NUCLEAR PHYSICS SETUPS

Learning Units:

1. The basic concepts of the GEANT4 modeling package.
2. A way to change the input parameters of the simulation.
3. Working with the g ++ compiler (GNU c ++ compiler), the basic commands of the console shell bash, the file manager Midnight Commander of the Linux operating system.
4. The program for viewing VRML-files of visualization DeepExploration, the program for viewing heprep-visualization files JAS.
5. What is the simplified model of the nuclear-physical experiment in GEANT4.
6. PhysicsList - methods.
7. DetectorConstruction methods.
8. PrimaryGenerationAction - methods.
9. RunAction-- methods.
10. DetectorSD methods.
11. Draw a diagram of class relationships.
12. Concepts of a session, an event, a track
13. The concept of a sensitive volume.
14. Coordinate systems in GEANT4
15. Ways of describing materials. Set a list of physical processes that are taken into account in modeling, configuration files and visualization, an event simulation cycle.

INSTRUMENT MAKING IN ADVANCED NUCLEAR PHYSICS EXPERIMENTS

Learning Units:

1. Introduction into course: overview of advanced nuclear physics experiments.
2. Introduction into collider experiments: hadronic colladiers, electron-positron colliders.
3. Particle detection at the hadronic colliders: strip detectors, pad detectors, calorimeters.
4. Online triggering and data reduction on the collider experiments.
5. Introduction into neutrino and dark matter experiments.
6. Cryogenic technologies for the neutrino and dark matter experiments.

7. Noble gases and pure crystals for the dark matter experiments.
8. Introduction into astroparticle experiments.
9. PMT technologies.
10. Scintillator technologies.
11. Imaging atmospheric telescopes and fluorescent telescopes .
12. Radio techniques for ultra-high energy astrophysics.
13. Facilities at the Tien-Shan cosmic station (I).
14. Facilities at the Tien-Shan cosmic station (II) -- with visit.
15. Future of nuclear, particle and astroparticle experiments.

BASICS OF PYTHON PROGRAMMING LANGUAGE
Learning Units:

1. Introduction in language, application areas, advantages and disadvantages.
2. Introduction in syntax: lists, if-then, loops, generators, etc.
3. Python patterns.
4. Introduction in advanced scientific libraries: numpy, scipy, matplotlib.
5. Operations with arrays in numpy.
6. Operations with files in numpy.
7. Plotting with matplotlib.
8. Statistical operations in numpy.
9. Fitting in numpy.
10. Overview of scipy features.
11. Advanced data analysis with Python (I).
12. Advanced data analysis with Python (II).
13. Compilation and binding with C/C++.
14. Graphical interface with Python.
15. Working with HDF5 format.

TECHNOLOGY OF DESIGNING DEVICES AND SYSTEMS

Learning Units:

1. General information on the design of instruments and systems. The place of design in the life cycle of the measuring device.

2. Principles of construction of instruments and systems. Classification of instruments and systems. Conditions and operating modes of the measuring device. Structures of devices and e 3. Development of a mathematical model of a measuring device. Stages of development of a mathematical model of a measuring device.

4. Elements of the mathematical model of the measuring device. An example of the development of a mathematical model of a measuring device.

5. Dynamic characteristics of the measuring device. Types of dynamic characteristics of the measuring device.

6. Basics of synthesis of the measuring device. Methodology of synthesis of the measuring device. Synthesis of the measuring device by the criteria of static accuracy. Pract. 6. Synthesis 7. Characteristics of measuring signals. Types of measuring signals. Types of signal characteristics.

8. Conversion of measuring signals. Types of measurement transformations. Conversion of a deterministic signal. Instantaneous transformation of a deterministic signal.

9. Analysis of the accuracy of the measuring device. Equation of measurement error. Evaluation of the measurement error at the design stage of the measuring device.

10. Calculation of the relative error of the sensitivity coefficient of the measuring device.

11. Fundamentals of reliability of measuring devices.

12. Organization of the design process.

13. Starting AutoCAD. AutoCAD's User Interface. AutoCAD's Cartesian Workspace. Modifying an Existing Drawing File.

14. 3-Dimensioning Drafting. Iso commands, 3D Shapes, User Coordinate System, Elevation, Thickness, Viewpoint, Viewports, 3D Polylines, 3D Face, 3D Surfaces of Revolution.

15. Advanced Display Modes Applications.

COMPUTERIZED TOMOGRAPHY METHODS

Learning Units:

1. Signal Processing Fundamentals. One-Dimensional Signal Processing. Continuous and Discrete One-Dimensional Functions. Linear Operations. Fourier Representation. Discrete Fourier Transform (DFT). Finite Fourier Transform. Data Truncation Effects.
2. Image Processing. Point Sources and Delta Functions. Linear Shift Invariant Operations. Fourier Analysis. Properties of Fourier Transforms. Two-Dimensional Finite Fourier Transform. Numerical Implementation of the Two-Dimensional FFT.
3. Algorithms for Reconstruction with Nondiffracting Sources. Line Integrals and Projections. The Fourier Slice Theorem. Reconstruction Algorithms for Parallel Beams. Reconstruction from Fan Projections. Equiangular Rays. Equally Spaced Collinear Detectors. Re-sorting Algorithm. Fan Beam Reconstruction from a Limited Number of Views. Three-Dimensional Reconstructions. Three-Dimensional Filtered Backprojection.
4. Measurement of Projection Data - The Nondiffracting Case. X-Ray Tomography. Monochromatic X-Ray Projections. Measurement of Projection Data with Polychromatic Sources. Polychromaticity Artefacts in X-Ray CT. Scatter. Emission Computed Tomography.
5. Ultrasonic Computed Tomography. Magnetic Resonance Imaging. Aliasing Artefacts and Noise in CT Images. Aliasing Artifacts. What Does Aliasing Look Like?
6. Noise in Reconstructed Images. The Continuous Case. The Discrete Case. Sampling in a Real System.
7. Tomographic Imaging with Diffracting Sources. Diffracted Projections. Homogeneous Wave Equation.
8. Inhomogeneous Wave Equation. Approximations to the Wave Equation. The First Born Approximation. The First Rytov Approximation.
9. The Fourier Diffraction Theorem. Decomposing the Green's Function. Fourier Transform Approach. Short Wavelength Limit of the Fourier Diffraction Theorem. The Data Collection Process.
10. Interpolation and a Filtered Backpropagation Algorithm for Diffracting Sources. Frequency Domain Interpolation. Backpropagation Algorithms. Limitations.
11. Mathematical Limitations. Evaluation of the Born Approximation. Evaluation of the Rytov Approximation. Comparison of the Born and Rytov Approximations. Evaluation of Reconstruction Algorithms. Experimental Limitations. Evanescent Waves. Sampling the Received Wave. The Effects of a Finite Receiver Length. Evaluation of the Experimental Effects. Optimization. Limited Views.

12. Algebraic Reconstruction Algorithms. Image and Projection Representation. ART (Algebraic Reconstruction Techniques).
13. SIRT (Simultaneous Iterative Reconstructive Technique). SART (Simultaneous Algebraic Reconstruction Technique). Modelling the Forward Projection Process. Implementation of the Reconstruction Algorithm.
14. Reflection Tomography. Introduction. B-Scan Imaging. Reflection Tomography. Plane Wave Reflection Transducers.
15. Reflection Tomography vs. Diffraction Tomography. Reflection Tomography Limits. Reflection Tomography with Point Transmitter/Receivers. Reconstruction Algorithms. Experimental Results.

AUTOMATION OF ACQUIRING DATA FROM COORDINATE-SENSITIVE AND TRACK DETECTORS

Learning Units:

1. Tasks and methods for automated information retrieval from coordinate and track detectors.
2. Detection of information from coordinate-sensitive detectors. The resistive method.
3. Detection of information from coordinate-sensitive detectors. Resistive-capacitive method.
4. Reading the coordinates from scintillation detectors.
5. Reading coordinates from semiconductor detectors of a discrete type.
6. Reading of coordinates from detectors on microchannel plates.
7. The work of charge-coupled devices as coordinate-sensitive detectors.
8. Reading with intermediate memorization on ferrites and tanks.
9. Reading from spark chambers with magnetostriction lines.
10. Acoustic method of information acquisition from spark chambers.
11. Television reading.
12. Application of electron-optical converters.
13. Coding Tracking Track.
14. Spiral scanning.
15. Scanning and tracking by a laser beam.

MULTIPARAMETER AND CORRELATION MEASUREMENTS

Learning Units:

1. Features of measurement of complex distributions.
2. Encoding information in multiparameter analyzers.

3. Amplitude amplitude measurements. Amplitude-time measurements.
4. Encoding information from multiple detectors.
5. Associative systems and preliminary selection of information.
6. Digital and analog windows in two-parameter analyzers.
7. Associative systems.
8. Multiparameter systems with mass memory. Tape Drives. Optoelectronic drives.
9. Averaging correlators.
10. Averager with analog memory.
11. Digital average.
12. Correlation time-of-flight spectrometers.
13. Correlation method in neutron spectrometry.
14. Pseudo Random Pulse Generation.
15. Analyzers and computer systems for correlation spectrometers.

DEVICES FOR NON-DESTRUCTIVE TESTING

Learning Units:

1. Introduction/History. What is NDT? Historical disasters that affected the development of NDT. The birth of Codes and Standards. NDT Qualification and Certification.
2. NDT Methods. Basic overview of 13 NDT methods. Abbreviations of those methods.
3. Visual Testing. Advantages and Limitations of VT. VT Qualification and Certification.
4. Visual Testing. Welding Gages for VT. Direct and Indirect VT. Discontinuities in manufacturing processes. Discontinuities in welding processes.
5. Visual Testing. Cause, prevention, and repair of welding discontinuities. Performing VT.
6. Welding Symbols. Purpose of welding and NDE symbols. Basic elements of welding and NDE symbols.
7. Welding Symbols. Supplementary welding and NDE symbols. Practical application of welding symbols.
8. Liquid Penetrant Testing. Basic steps of PT. Mechanics of PT. Types of penetrants, removers, and developers. Performing PT.
9. Magnetic Particle Testing (MT). Basic principles of MT. Four steps of MT.
10. Magnetic Particle Testing (MT). MT equipment and media. Performing MT.

11. Radiographic Testing (RT). Types of RT sources. Radiation.
12. Radiographic Testing (RT). RT equipment. RT Safety.
13. Radiographic Testing (RT). Producing a radiograph. RT image quality. RT discontinuities.
14. Ultrasonic Testing. Principles of sound. UT equipment. UT measurements and flaw detection. UT calibration.
15. Ultrasonic Testing. Data scan presentation methods. Phased array UT. Alloy identification. Eddy Current Testing (ECT).

MEDICAL PHYSICS

Learning Units:

1. Physics basis of heat and temperature, thermography and temperature scales.
2. Mapping of body's temperature, heat therapy.
3. Use of cold in medicine, cryosurgery and safety aspects.
4. Conservation of energy in the body, energy changes in the body, work and power, heat losses from the body.
5. Measurement of the pressure in the body, pressure inside skull, eye, digestive system, skeleton & urinary bladder, hyperbaric oxygen therapy.
6. Physics of lung and breathing. The air ways, blood & lung interaction, measurement of lung volumes, pressure air flow volume relationship of the lungs .
7. Physics of alveoli, breathing mechanism, air-way resistance, work of breathing, physics of some common lung diseases.
8. Physics of cardiovascular system. Major components of cardiovascular system, oxygen and carbon-di-oxide exchange in the capillary system.
9. Work done by the heart, blood pressure and its measurements, transmural pressure, Bernoulli's principle applied to cardiovascular system.
10. Blood flow laminar & turbulent. Heart sounds, physics of some cardiovascular diseases.
11. Electricity within the body. The nervous system & neurons, electrical potential of nerves, electromyogram, electrocardiogram, electroencephalogram, electroretionogram, electrooculogram
12. Magneto cardiogram & magnet encephalogram, electric shock ,high frequency and low frequency electricity in medicine, magnetism in medicine.
13. Sounds in medicine. General properties of sound, body of drum, the stethoscope, ultrasound picture of the body, ultrasound to measure motion, physiological effects of ultrasound in therapy, the production of sound.

14. Physics of ear and hearing. The outer ear, middle ear and the inner ear, sensitivity of ears, testing hearing, deafness & hearing aids.
15. Light in medicine. Measurement of light and its units, application of visible light in medicine, application of UV and IR in medicine.

MEDICAL INSTRUMENTS and MEDICAL ENGINEERING
Learning Units:
1. Sources of biomedical signals. Basic medical instrumentation system, performance requirements of medical instrumentation systems. General constraints in design of medical instrumentation systems.
2. Bioelectric Signals and Electrodes: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrodes for ECG, Electrodes for EEG, Electrodes of EMG.
3. Bio amplifier. Single ended bio amplifier. ECG amplifier. Band Pass filtering, isolation amplifiers-transformer and optical isolation- isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.
4. Biomedical recorders. Electrocardiograph-block diagram description, ECG leads, Artefacts, Vectorcardiograph, Phonocardiograph, Electroencephalograph, Electromyograph.
5. Measurement of heart rate, measurement of pulse rate. Blood pressure measurement, measurement of temperature, measurement of respiratory rate. Korotkoff's method measurement of respiratory rate: Impedance Pneumograpy.
6. Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, hearing aids-conventional, digital hearing aid, cochlear implants.
7. Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter.
8. Cardiac Output Measurement-indicator dilution, dye dilution.
9. Blood Flow Meters. Electromagnetic blood flow meters, Ultrasonic blood flow meters, Nuclear Magnetic Resonance blood flow meters.
10. Cardiac pacemakers and defibrillators. External pacemaker, Implantable pacemaker, Types of Implantable pacemakers, Programmable pacemaker, Rate-responsive pacemakers.
11. DC defibrillator, Implantable defibrillators. Patient safety: Electric shock hazards, Leakage currents, macro shock, micro shock hazards and preventions, safety codes and analyzer.
12. Principles of surgical diathermy, surgical diathermy machine, automated electro-surgical systems, electrodes used with surgical diathermy.

13. Haemodialysis machine. Function of kidney, artificial kidney, dialyzer, membranes for hemodialysis, portable kidney machine.
14. Ultrasonic diagnostic methods. Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M- mode), Constant depth mode (C-mode), Colour Doppler flow imaging.
15. Basics of magnetic resonance imaging. Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Rotating frame of reference and RF magnetic field, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.

CLINICAL ENGINEERING

Learning Units:

1. Definition, role of clinical engineering within the hospital organization.
2. Major functions of a clinical engineering department, flowchart and model of a clinical engineering department, computerized maintenance and management system.
3. Clinical information systems, picture archiving and communication systems (PACS).
4. Duties and responsibilities, clinical engineer as consultant, clinical engineer as investigator and expert witness.
5. Patient safety and clinical engineers, accident investigation, electromagnetic interference, WMTS interference issues.
6. Technology evaluation, strategic technology planning, technology and alternatives, risks, hazards, and clinical efficacy.
7. Conceptual needs analysis, testing laboratory and engineering evaluation, technical specifications and other requirements.
8. Management engineering in health care, cost effectiveness and productivity
9. Personnel management, medical technology assessment process.
10. In-house clinical and technical evaluations, planning strategies, quality.
11. Medical technology management practices.
12. Health care strategic planning utilizing technology assessment.
13. Vendor and service management. ASZX
14. Medical device research and design.
15. Maintenance and repair of medical devices, medical device troubleshooting, safety standards and regulations.

MEDICAL ELECTRONICS

Learning Units:

1. Types of medical device.
2. Medical information and their use in the diagnostic process.
3. Sensors of non-electrical quantities.
4. Direct and indirect measurement of blood pressure.
5. Flow measurement and biochemical parameters of blood.
6. Medical imaging equipment (emissive, transmissive, reflective), characteristics (contrast, resolution).
7. Ultrasonic diagnostic equipment, display modes.
8. Computed tomography (CT), CT equipment design, image reconstruction.
9. MRI - physical principles of MRI imaging, MRI image coding, design MRI equipment.
10. Other types of display devices: PET, SPECT, OCT.
11. Bioelectromagnetism. Biological sources of electric and magnetic fields, the principles for measuring them.
12. Hardware aspects of the biosignal measurement, instrumentation and isolation amplifiers.
13. Electrocardiography, electroencephalography, electromyography - leads, diagnostic use.
14. Bioelectric stimulation, pacemakers, defibrillation.
15. Biomedical electronics - applications in consumer electronics.

MEDICAL IMAGING SYSTEMS

Learning Units:

1. Fundamentals of X-ray. Electromagnetic radiation. Interactions between X-rays and matter. Biological effects of ionizing radiation. Intensity of X-ray beam. Attenuation, Generation and Detection of X-rays - X-ray generation, X-ray generators, Filters.
2. Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers. X-ray detectors, X-ray image characteristics - Spatial resolution, Image noise, Image contrast. Receiver operating curve (ROC).
3. X-ray imaging. X-ray diagnostic methods. Conventional X-ray radiography, Fluoroscopy. Angiography, Mammography and Xeroradiography, Image subtraction.
4. Computed tomography. Conventional tomography, Computed tomography - Radon Transform (Projections) and Fourier Slice theorem. Algorithms for image reconstruction: parallel and Fan beam data, Spiral CT. Recent developments - Digital radiography.

5. Ultrasound imaging. Fundamentals of acoustic propagation - Stress strain relationship, Characteristic impedance, Intensity, Reflection and refraction. Attenuation, absorption & scattering, Doppler effect, Generation and detection of Ultrasound- Piezoelectric effect, Ultrasonic transducers.
6. Ultrasonic diagnostic methods. Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M- mode), Constant depth mode (C-mode),
7. Doppler methods, Duplex imaging, Tissue characterization, Colour Doppler flow imaging,
8. Image characteristics - Ultrasonic texture or speckle, Speckle reduction, Compensation of phase aberration, Biological effects of ultrasound.
9. Radionuclide imaging. Fundamentals of Radioactivity - Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity,
10. Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radionuclides, Generation & Detection of Nuclear Emission - Radionuclide generators, nuclear radiation detectors, Collimators,
11. Radionuclide imaging systems- Gamma Camera, SPECT, PET.
12. Basics of magnetic resonance imaging. Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Rotating frame of reference and RF magnetic field, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.
13. MRI system & imaging methods. Magnetic field gradients, NMR Coil/Probe, Transmitter, Receiver, Data acquisition.
14. Imaging Methods- Introduction, slice selection, frequency encoding, phase encoding, Spin-Echo imaging- Gradient echo imaging. Characteristics of MRI images- spatial resolution, image contrast.
15. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields, Imaging safety, Functional MRI.DICOM Standards

BIOMEDICAL EQUIPMENTS

Learning Units:

1. Clinical laboratory instruments.
2. Medical diagnosis with clinical tests, spectrophotometry-components, clinical flame photometer, ion-selective electrode based analyzers.
3. Blood gas analyzers. Acid-base balance, blood pH measurement, measurement of blood pCO2, measurement of blood pO2, intra-arterial blood gas monitoring, complete blood gas analyzer.

4. Blood cell counters. Types of blood cells, Coulter counter.
5. Automatic recognition and differential counting of cells.
6. Audiometer. Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, audiometer system Bekesy, evoked response audiometer system.
7. Hearing aids. Digital hearing aid, cochlear implants.
8. Instruments of surgery. Principles of surgical diathermy, surgical diathermy machine.
9. Automated electro-surgical systems, electrodes used with surgical diathermy, safety aspects in electro-surgical units, surgical diathermy analyzer.
10. Physiotherapy and electrotherapy equipment. High frequency, heat therapy, short wave diathermy, microwave diathermy.
11. Ultrasound therapy unit
12. Electro diagnostic therapeutic apparatus, pain relief through electrical stimulation, bladder and cerebral stimulators.
13. Haemodialysis machine. Function of kidney, artificial kidney, dialyzer, membranes for hemodialysis, portable kidney machine.
14. Mechanics of respiration, artificial ventilation
15. Types of ventilators, ventilator terms, classification of ventilators. Pressure volume flow diagrams, modern ventilators, high frequency ventilators, humidifiers, nebulizers and aspirators.

LASERS AND FIBER OPTICS IN MEDICINE

Learning Units:

1. Laser physics-fundamentals, principles, advances.
2. Medical Lasers- fundamentals, principles (co2, Nd-YAG, eximer, dye - lasers) advances (semiconductor laser, free electron laser, Miscellaneous laser techniques).
3. Medical Laser Systems-fundamentals, principles. Laser safety-fundamentals.
4. Applications of lasers in therapy & diagnosis.
5. Laser assisted diagnosis and therapy-fundamentals, interaction of laser beams and materials-principles.
6. Laser interaction with tissue-principles. Laser assisted diagnostics-principles, applications of lasers in diagnosis and imaging-advances,
7. laser surgery and therapy-principles-photo thermal & photomechanical mechanisms, thermal interaction between laser and tissue-advances.

8. Single optical fibers. Introduction to OFC, block diagram of OFC, analog link and digital link,
9. Optical fibers-fundamentals, light transmission in optical fibers-principles, optical properties of optical fibers-advances,
10. Fabrication of optical fibers- principles, optical fibers for UV, visible, IR light-principles,
11. Power transmission through optical fibers-principles, modified fiber ends and tips- principles, fiber lasers-advances.
12. Optical fiber bundles. Non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiber optic bundles for imaging devices-fundamentals & principles.
13. Fiber scopes and endoscopes-fundamentals, fiber optic imaging systems-advances.
14. Clinical applications of fiber optic laser systems. Endoscopy: Introduction, endoscopic imaging systems-fundamentals, principles, advances, endoscopic diagnostics-advances. Endoscopic therapy-fundamentals, endoscopic ultrasound imaging-principles.
15. Fiber optic laser systems in cardiovascular disease, flow diagram for laser angioplasty & photodynamic therapy.

BIOSENSORS AND SMART SENSORS

Learning Units:

1. Biosensors, Advantages and limitations, various components of biosensors, the growing of biosensor.
2. The biosensor family, the biomolecule ingredients, proteins, enzymes complexes, enzymes kinetics, the proteins of the immune systems.
3. Transducers in biosensors. Calorimetric, optical, potentiometric, amperometric, conductrometric, resistormetric, piezoelectric, semiconductor, impedimetric transducers.
4. Mechanical and molecular electronics based transducers. Chemiluminescences based biosensors.
5. Application and uses of biosensors. Biosensors in clinical chemistry, medicine and health care.
6. Biosensors for veterinary, agriculture and food. Biosensors for personal diabetes management, application of biosensors to environmental samples. Biochips and their application to genomics.
7. Amperometric assay techniques. Analysis of charge transfer, volumetric techniques, potential step techniques, non steady state measurement.
8. Applications of charge transfer measurement of the oxygen electrode.
9. Source of error. Depletion of sample, non-Faradic current error, selectivity interference from other electro active species,
10. Amperometric electrodes for estimation of Ion concentration, macromolecules system, Redox enzymes, modified electrodes, mediated electron transfer, microelectrode fabrication and application.

11. Photometric assay techniques. Energy transition, ultraviolet and visible absorption spectra, fluorescence and phosphorescence,
12. Infra Red transitions, light scattering, Raman scattering, applications of ultraviolet visible spectra, indicator linked bioassay, irrational spectroscopy,
13. The optical transducer, wave guides in sensors, device construction, PH optical probes, light scattering analysis.
14. Optical biosensors & other techniques. Indicator labeled bioassay, chemiluminescence, bioluminescence,
15. Surface plasma resonance, piezoelectric based sensors and surface acoustic waves.

BIOMEDICAL DIGITAL SIGNAL PROCESSING

Learning Units:

1. The nature of biomedical signals, the action potential, objectives of biomedical signal analysis, Difficulties in biomedical signal analysis, computer aided diagnosis.
2. Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics, EEG analysis.
3. EMG signal characteristic and analysis
4. Sleep EEG. Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, and Event history analysis for modeling sleep.
5. Adaptive filters. Principle of an adaptive filter, the steepest descent algorithm.
6. Adaptive noise canceller, cancellation of 60 Hz interference in electrocardiography, applications of adaptive filters.
7. Canceling donor - heart interference in heart-transplant electrocardiography, Cancellation of ECG signal from the electrical activity of the chest muscles, canceling of maternal ECG in fetal ECG.
8. Cancellation of High frequency noise in Electro - surgery.
9. Signal averaging. Basics of signal averaging, a typical signal averager, signal averaging as a digital filter, Removal of artifacts by averaging.
10. Filtering for removal of artifacts. Random noise, structured noise and physiological interference, stationary versus non stationary process.
11. High frequency noise in ECG, motion artifact in ECG, power line interference in ECG signals, Maternal interference in Fetal ECG, muscle contraction interference in VAG signals.
12. Cardiological signal processing. Pre-processing. ECG QRS.

13. Detection techniques. Rhythm analysis. Arrhythmia detection Algorithms.
14. Automated ECG Analysis. ECG Pattern Recognition. Heart rate variability analysis.
15. ST-segment analyzer, portable, arrhythmia monitors.

CATALOG OF DISCIPLINES

EDUCATIONAL PROGRAM IN ENGLISH "INSTRUMENT MAKING"
THE SPECIALTY 5B071600 - INSTRUMENT MAKING

	Discipline Name, Credits, Prerequisites	Purpose, tasks, course summary	Competences (results of training)
	1. GENERAL EDUCATION		
GE	The modern history of Kazakhstan, **3 credits** Prerequisites: no	Course objective. The purpose of the course is to give students objective historical knowledge about the main stages of modern history Kazakhstan; direct students' attention to the problems of formation and development of independent statehood in Kazakhstan, spiritual culture, continuity of ethno genesis; bring home to students the essence of the fundamental problems of history, teach them scientific methods of historical knowledge, they form a scientific world outlook and civic position. The study of Modern History of Kazakhstan has a distinctive role in the education curriculum as it challenges students to consider the great social, technological, economic, political and moral transformations from the late eighteenth century to the present. It requires students to analyses the causes, progress and effects of these transformations and, finally, to make judgments about them. Modern History of Kazakhstan is especially relevant to the lives of students, as the events and issues that form its content are, in many cases, still	- understand the modern history of the Republic of Kazakhstan; - explain the leading trends, key facts, events and processes in Kazakhstan throughout history; - discuss more value-ideological norms and relations of selected experience of historical development, ownership of cultural traditions, society, its people; - in modern conditions, to study the history of the state and law on the basis of research experience and knowledge, in order to recreate an objective picture of the history of the state and the law of the country; - identify and extract information from different sources; - preparation of speeches, scientific articles and reports, reports and essays, writing term papers on key issues of national history.

		current. The study of «Modern History of Kazakhstan» also contributes to the development of skills that are of great importance in today's workforce. The fluent communication of thoughts and ideas gleaned from the critical analysis of primary and secondary sources is a sought after skill. The ability to deconstruct texts and narratives, pose intelligent questions, test hypotheses and make critical use of information technologies is essential to living and working in the twenty-first century.	
GE	Kazakh (Russian) Language **3 credits** Prerequisites: no	Course objective. The goal of the course is to develop students' skills in reading, speaking, listening, writing in a Kazakh (Russian) language as part of the university program. Tasks: - expansion of lexical minimum of common words and phrases; - acquirement of lexical and terminological minimum in the specialty; - the construction of various types of speech activity: conversation, description, information; - reproduction and adapted to the production of simple pragmatic texts, dialogic and monologue, orally and in writing on topics relevant to the social and consumer and professional fields, according to various kinds of speech activity: speaking, listening, reading, writing.	- to argue the features of the scientific style of speech; - apply the plan of transformation of the thesis (expansion, addition); - to form and develop the skills of drawing up nominal, questions and plans of theses. - determine the type and amount of scientific information contained in the text; - analyze the structural and semantic organization of the text; - to conduct linguistic-semantic analysis of the text; - formulate a topic, identify system problems, select microtomes, formulate the main idea (text paragraph).

GE	Foreign Language **3 credits** Prerequisites: no	Course objective. The goal of the course is to develop students' skills in reading, speaking, listening, writing in a foreign language as part of the university program. As well as knowledge of the phonetic, spelling, vocabulary, grammar rules to learn foreign languages. Phonetics: the pronunciation and intonation, rhythmic characteristics of a foreign language, reception and reproduction of the sound of speech systems. Spelling: sound-letter language system, basic spelling rules. Vocabulary: word-formation models; lexical minimum volume of 2,500 units of the base language and the terms corresponding to the profile of the specialty.	- use the basic rules of reading and pronunciation of letters, alphabet and letter combinations in the speech flow; - use the spelling of letters and letter combinations corresponding to certain sounds, spelling corresponds to the frequency of lexical and grammatical features of the main language; - use vocabulary: word-formation models, contextual meanings of ambiguous words, terms and lexical sublingual design, corresponding to the profile of the studied specialty; - apply the most frequent specific grammatical phenomena, basic and natural human and technical sublanguages; - read short texts with a dictionary and without a dictionary, search for specified information to understand the content of the reading; - write a personal letter to a friend by e-mail, dictation, fill out a form, a description of a friend, write a postcard; - translate text from a foreign language at home using a dictionary in accordance with the rules of the target language; - understand the brief record and definitions in the studied subjects in a foreign language; - express your thoughts and speak in a foreign language, respectively, at the level of the speech language, ask and answer questions, conduct a conversation in a foreign language in terms of the

			volume of the subjects being studied, using adequate communication signals, to transmit content, read, heard.
GE	Philosophy **3 credits** Prerequisites: The modern history of Kazakhstan	Course objective. The goal of the course is mastering the philosophical legacy, gaining acquaintance with the main theoretical issues of philosophy, having students worked out a philosophical way of thinking and comprehending as well as the skill to think logically and creatively and to defend their own position logically convincingly. Tasks: • the study of the cognitive function of philosophy in the context of the development of world science; • consideration of the main trends shaping the philosophical and scientific rationality; • an analysis in the light of the philosophy of modern interpretations of the unity of the world, the relationship of its structural levels and spheres of existence and development; • the development of conceptual thinking culture, scientific approach to the problems of his specialty.	- improve their ability to solve problems, the ability to organize ideas and problems and the ability to distinguish what is necessary from what is not; - to become more able to look at things from different points of view, understand different points of view and open a common language for them; - learn to critically examine their own views, as well as the opinions of others; - develop the ability to understand and explain complex materials; - learn to distinguish good reasoning from attempts to manipulate opinions, build complex arguments and evaluate the arguments of others; - develop good interpretive, comparative, argumentative, analytical and descriptive speaking and writing skills that will allow them to communicate their ideas clearly and effectively; - work with philosophical texts, use them to study actual problems of human society and nature; - analyze the fundamental issues of the origin and evolution of the scientific picture of the world; - focus on the conceptual apparatus and terminology of scientific knowledge of philosophy;

			- develop and defend their scientific position; - to solve theoretical and methodological issues in the field of science.
GE	ICT Technologies **3 credits** Prerequisites: no	Course objective. Discipline aims to familiarize students with the theoretical and practical information, which reflect the main trends in the development of computer science, maintenance and acquisition of knowledge and skills of the students in the use of modern software in the subject field, the development of efficient algorithms for solving scientific and engineering problems of mathematical and numerical modelling using modern programming languages to learn the basics of computer graphics, database design, the basic concepts of networking. This course aims to improve the skills of students on the use of information technology. The course is supported by the advanced practicum. The objective of the discipline is to acquire theoretical knowledge about information processes, on new information technologies, local and global computer networks, methods of information protection. During the program, students must learn and rational use of the opportunities offered by computer technology to solve life's problems, get skills to use word processing, spreadsheet, database, different categories of applications.	- identify the main trends in the field of information and communication technologies; - know the economic and political factors contributing to the development of information and communication technologies; - know the architecture, be able to calculate and evaluate the performance of supercomputers; - know the features of different operating systems; - use information resources for searching and storing information; - work with spreadsheets, perform data consolidation, build charts; - work with databases; - apply methods and means of protecting information; - design and create simple websites; - carry out the processing of vector and raster images; - create multimedia presentations; - use different social platforms for communication; - use various forms of e-learning to expand professional knowledge; - use various cloud services.

2.BASIC DISCIPLINES			
BD	Mathematics 1 **2 credits** Prerequisites: no	Goal of the course of mathematics-1: -introduce students to the elements and methods of differential and integral calculus of functions of one variable, and some of their applications, in preparation for the study of other mathematical techniques from other disciplines; objectives: study and development of a theoretical material in the framework of the work program; the solution of tasks specified in accordance with the study of theoretical material;-develop skills to solve specific problems. Contents: The numerical sequence. The function and its limit. Continuity. The derivative of a function. Higher-order derivatives. The L'Hospital theorem. Local extremes of the function. The necessary and sufficient conditions of optimality. The indefinite integral and its properties. The Newton-Leibniz formulae.	- know the structure of the space of real numbers, the convergence of numerical sequences, understanding of the convergence criteria; - master the basic methods of researching the properties of functions; - understand the concepts of continuity of functions, their differentiability, integrability; - apply the basic methods of mathematics to solve various mathematical problems of another discipline; - acquire practical skills for solving problems; - choose the method of solving problems and solve them; - put into practice the differentiability and integrability of numerical methods; - know the specific conditions of convergence of numerical methods; - to obtain practical skills in applying differential and integral calculus in problems of mechanics and physics.
BD	Mathematics 2 **3 credits** Prerequisites: Mathematics 1	Purposes and problems of a course: "Mathematics - II». Formation of students' scientific basis of knowledge of the objective laws of nature, the most important of which are studied physical sciences, requires a thorough knowledge of mathematics as a science subject area, which is the study of quantitative certainty of any object, process and	- understand the basic mathematical concepts involved in the program, their interrelationship, interdependence and interaction not only among themselves, but also with other mathematical disciplines;

		phenomenon. Among the mathematical disciplines in the study of real processes of macro and micro occupies an important place course "Mathematics - II», the need for expansion and deepening of the study due to the development and progress of the level of development of nuclear physics. Contents: The course "Mathematics - II» - the main course in the preparation of physical and technical experts: nuclear physics, high school teachers, employees of scientific - technical sphere, etc.;	- carefully and thoroughly substantiate the reasoning, without cluttering it with unnecessary details; - have an idea of how to solve problems in mathematics, algebra and geometry; - acquire practical skills for solving problems; - choose the correct method of solving problems and solve it.
BD	Physics 1 **3 credits** Prerequisites: Mathematics.	*Course objective.* Develop understanding the concepts in electricity and magnetism, reinforce general problem solving skills and reinforce conceptual understanding through the use of problem solving skills. Electricity and Magnetism affords students an opportunity to increase their ability to use fundamental models in classical electricity and magnetism to describe and explain nature and also to earn university credit. In practice, many prospective science and engineering students use Physics 1 to gain excellent preparation for their required introductory physics courses in university while students who aspire to non-science majors often apply any credit earned toward fulfillment of the science requirement of their undergraduate degree.	- determine power and energy characteristics of the electrostatic field, the relationship between them; - apply principle of superposition and the flux of the stress vector, the Gauss theorem; - use laws of direct current; - determine induction of the magnetic field, the flux of the magnetic induction vector, the circulation theorem; - demonstrate application of the law of Ampere and the Lorentz force, the law of electromagnetic induction; - find characteristics of electric, magnetic (in vacuum and matter) and gravitational fields and thermal equilibrium radiation using the Maxwell equations and elements of field theory (vector and scalar fields);

			- find forces acting on the charged particles in the electric and magnetic fields, as well as their combined action and conductors with a current in a magnetic field; - determine main parameters of electric currents in vacuum, gases, plasma; - find main characteristics of free harmonic, damped, as well as forced vibrations, including elements of the theory of functions of a complex variable and differential equation; - find energy, amplitude and speed of wave propagation.
BD	Professionally-Oriented Kazakh (Russian)Language **2 credits** Prerequisites: Kazakh (Russian) Language	Course objective. Mastering the principles of technical writing, getting skills of construction theoretical calculations, familiarity with the scientific and technical documentation in the subject area of specialty, and the study the theory, methods and computer simulation technology in the study and design of industrial information systems and processes.	- apply modern vocabulary and terminology in Kazakh (Russian) language for technology and project management methodology, project management processes, modern project management software. - apply organizational project management tools to determine the hierarchical structure of project work, use formal methods for estimating time and resources of project goals, determining the number and sources of funding, planning and taking risks into account.
BD	Basics of Electronics **3 credits** Prerequisites: Physics 1	In the course of training, it is necessary to pay attention to the advantages of electronics over other means of information transmission, such as universality, economic efficiency, simplicity of distribution among consumers, simplicity of transformation into other forms of energy, transfor-	- implement the basic principles of construction and operation of electronic devices; - use the latest achievements of electronics in various areas of professional activity;

		mation prostate. To state the physical and energy processes in electronic devices, based on modern scientific views, introduce the principles of calculation and research of complex electronic devices, analysis of physical processes and phenomena. In the process of training, future specialists will learn the basics of the theory of conversion and production of signals, the most important electrical quantities, units of measurement, transformations, calculation and modification of various components of electronic devices.	- implement systematic, theoretical and basic knowledge in various educational spaces; - use practical skills for setting non-complex research tasks, own professional speech culture.
BD	Physics 2 **2 credits** Prerequisites: Mathematics. Physics 1	*Course objective.* This course provides an introduction to optical science with elementary engineering applications. Topics covered in geometrical optics include: ray-tracing, aberrations, lens design, apertures and stops, radiometry and photometry. Topics covered in wave optics include: basic electrodynamics, polarization, interference, wave-guiding, Fresnel and Fraunhofer diffraction, image formation, resolution, space-bandwidth product. Analytical and numerical tools used in optical design are emphasized. Graduate students are required to complete assignments with stronger analytical content, and an advanced design project.	- represent the main ray tracing; - apply imaging systems; - depict advanced ray tracing; - design the optical system;- determine the scalar linear wave propagation and wave properties of light; - apply the Fourier approach/system to the propagation of light; - demonstrate spatial filtering, resolution, coherent and incoherent image formation, volume-striped product; - illustrate wavefront modulation, holography, diffraction optics, subwave optics: “nanophotonics”, “metamaterials”.

BD	Electrical Engineering **3 credits** Prerequisites: Physics 1	*Course objective.* State the physical and energy processes in electrical circuits based on modern scientific views, acquaint with the principles of calculation and research of complex devices and electrical circuits, analysis of electrical and magnetic processes and phenomena.	- master at a high level the necessary information for the intensification of production processes; - apply the construction of a fully automated production capacity; - separate the features of the energy lines from the information lines, it is easy to solve any problems associated with this
BD	Professionally-Oriented Foreign Language **2 credits** Prerequisites: Foreign Language	Course objective. Learning of special terminology, vocabulary in a foreign language, the theoretical foundations of project management methodology, project management process groups, drafting documents of the project, the project management directly using the modern tools of the software.	- possess modern vocabulary and terminology in English for technology and project management methodology; - organize project management processes; - use modern project management and software development; - apply organizational project management tools to determine the hierarchical structure of the project; - use formal methods for estimating the time and resources of the project; - determine the amount and sources of funding to plan and consider risks.
3. MAJORS DISCIPLINES			
CC	Integral and microprocessor circuitry 3 credits	Course purpose studying: - circuit design methods for building elements, components and devices of computers and their principles of operation, as well as the design of various digital and analog electronic devices;	- understand the structure and operation of microprocessors, technology of integration and technological condition of the properties of the microprocessor structure, progress, trends and overview of microprocessors, structure and operating systems of microprocessors, technology, parameters and operation of memories;

	Prerequisites: Physics 1, 2, Basics of Electronics, Electrical Engineering	- circuit design of the basic logic elements of digital devices; - principles of construction and operation of digital devices of combinational and sequential types; - methods of organization and features of the functioning of semiconductor storage devices; - logic devices with programmable characteristics; - methods of converting analog signals based on operational amplifiers; - circuitry analog-digital and digital-analog converters.	- use the programming and activation of the development of microprocessor systems; - apply the main models of programmable logic integrated circuits; - use the software environment; - design various digital electronic circuits; - use devices for programming logic integrated circuits; - solve problems by applying the features of the FPGA.
CC	Basics of Information and Measurement Technologies **2 credits** Prerequisites: Physics 1, 2 Basics of Electronics, Electrical Engineering	Course objective. It will be aware the basic concepts, the principles of construction and a research of information and measuring systems which are based on a mathematical apparatus of transformation of measuring signals, technologies of measurement, transfer and processing of signals and data on noiseproof coding, use of modern information and communication channels of communication, on algorithms of enciphering and decoding of transmitted data, methods of a research of metrological characteristics are systematically stated.	- create information and measurement systems; - develop technical systems; - apply functioning, information and measuring systems; - develop hardware and software; - to carry out measurements, showing the characteristic specific features and features of the methods and the reality of the execution of measurement processes; - use schemes with different characteristics; - use real measurement hardware and software; - apply virtual information and measuring systems using modern information and modeling technologies of various types, including computer, mathematical, physical, with extensive computer use, which helps to conduct a measurement experiment.

4. ELECTIVE COURSE			
GE	Computer science **3 credits** Prerequisites:	*Course objective.* This course teaches the student to apply fundamental procedural programming concepts to the programming language C++. Programming principles and constructs, such as data types, common control flow structures, basic data structures, and console input/output will be presented. The objective of this class is to expose the student to procedural programming using C++ and to increase the depth of students' knowledge about several implementation issues. Knowing C++ will be useful in the students' jobs in IT organizations as developers or managers because it will enable them to code efficiently, communicate effectively with colleagues and understand and improve software development practices in their organizations. At the end of the course, we expect people to have a good understanding about the concept of object-oriented programming using C++, be able to write and read basic C++ code.	- understand the structured programming procedure; - analyze and develop algorithms; - apply the syntax and semantics of the C programming language; - use logical and syntactic debugging; - manage the developed software; - apply elementary methods using arithmetic operators and mathematical expressions in C++ programming; - select the appropriate data type to represent the data; - write programs in C++ using cycles (while, dowhile, for), sequential files for input and output, functions for transferring control, arrays, including sorting and searching for arrays, pointers; - solve programming problems using C++.
GE	Analytical Geometry **2 credits** Prerequisites: no	Purposes and problems of a course: The aim of teaching is to teach students the basics of linear algebra, in which a central place is given to one of the most important ideas of mathematics. Contents: in the course "Linear Algebra and Analytic Geometry 1" examines the following topics: the complex numbers and operations on them, the concept of the residue, the actions on them; action on	The competence gained as a result of this module, the student must: know: the theory of algebraic equations, the basic properties of determinants and matrices, an algebraic and geometric description of lines and surfaces of second order, initial information about groups, rings and fields. skills: use Gauss to calculate the determinants,

		matrices, Gauss reducing a matrix to echelon form, the computation of inverse matrices, arithmetic space, linear relationship, the lemma for substitution, rings, fields, examples and elementary properties, etc.	solutions and study systems of linear algebraic equations, the study of vector systems for the linear dependence of the calculation of the inverse matrix. have: practical skills in the field of complex numbers in residue rings and polynomials, using the method of problems of coordinate geometry with solutions, to set the equations of lines and planes in their various tasks.
BD	Mechanics and molecular physics **3 credits** Prerequisites: Mathematics.	*Course objective.* This course is a first semester, calculus based physics course for physical science and engineering majors. It introduces basic concepts, theory, and applications of classical mechanics (matter and motion, kinematics and dynamics of particles, rigid and elastic bodies, fluids, waves) and thermal physics (heat, thermodynamic processes). This course: 1. Introduces basic physics concepts in mechanics and thermodynamics; 2. Provides students with the fundamental understanding of the principles and laws of classical physics; 3. Teaches problem solving techniques; 4. Helps to develop analytical thinking; 5. Introduces the applications of differential and integral calculus in physics; 6. Teaches how to apply the physical principles and knowledge to other disciplines; and, 7. Demonstrates how observation, experiment, and theory work together to continue to expand the	- understand and apply the laws of Newton's dynamics, conservation laws for determining the movement of physical bodies, basic concepts and laws in thermodynamics, basic concepts and laws in transport phenomena; - apply basic mathematical tools, including vectors and calculus, to solve physical problems; - make use of physical intuition, including the ability to guess an approximate or conceptual response to a physical problem; - analyze the result of the calculation; - apply physical knowledge to other disciplines, including physics and engineering; - illustrate how physical observation, experiment and theory worked together on the development of inventions that advanced our civilization.

		frontiers of knowledge of the physical Universe. The emphasis is on improved critical thinking skills, and on developing an ability to approach and solve physics problems.	
GE	Occupational Safety and Health **2 credits** Prerequisites: no	*Course objective.* Preparation of highly qualified specialists who possess the theory and practice of protecting a person from dangerous and harmful environmental factors in all spheres of human activity, including protection from emergencies.	- explain the main technospheric and artificial hazards, their properties and characteristics, the nature of the impact of harmful and dangerous factors of production on humans and the environment, methods of protection against them; - develop legislation and legal acts in the field of life safety, methods and technologies of protection in emergency situations; - acquire theoretical knowledge and practical skills necessary to create safe and harmless living conditions; - identify the main hazards of the human environment, assess the risk of their implementation; - understand modern ideas about natural and man-made processes that cause a violation of safety requirements for vital activity, environmental protection, make decisions in emergency situations and protection; - apply monitoring and measurement methods in the field of safety and environmental protection; - own methods and technologies of protection in emergency situations; - use knowledge about the organization of safety in emergency situations at the facilities of the

			economy, in everyday life, in the environment.
BD	Chemistry **3 credits** Prerequisites: Mathematical analysis 1,2, Mechanics and molecular physics.	Course objective: is to familiarize students with the basic laws, concepts and theories of chemistry, as well as the basic physical and chemical properties of the elements in the periodic system for solving practical problems in the field of chemistry	- understand the main laws, concepts and theories of chemistry; - describe the physical and chemical properties of the elements of the periodic system of elements of Mendeleev; - solve practical problems in chemistry; - offer optimal reaction conditions; - write charts on the conversion of chemicals from each other; - demonstrate theoretical knowledge for passing intermediate and final examinations; - conduct experiments in the laboratory during laboratory studies and use various laboratory equipment and installations; - analyze the results of educational activity of chemistry, summarize them through scientific essays, presentations, etc; - discuss the results obtained in the team; - consider the reactions occurring during the experiment, and their explanation with theoretical concepts; - prepare a critical report on the results and observations; - apply the knowledge gained in other disciplines; - substantiate the role of chemistry for the study of other sciences.

BD	Atomic Physics **3 credits** Prerequisites: Mathematics 1,2, Analytical Geometry, Mechanics and molecular physics	Course objective is Represent the atomic physics as a theory that has arisen as a result of generalization of observations, experience and experiment in the framework of lectures, practical and laboratory classes supplied, understanding of the limits of application of classical physics models and hypotheses, concepts of critical stages in the development of atomic physics, basic laws of atomic physics, basic physical phenomena of atomic physics, methods of observation and experimental research;	- understand the concept of a good quantum number and simultaneous observability; - understand quantum numbers, including their physical significance, and quantum-mechanical states of the hydrogen atom; - understand the origin of the width and shape of lines in atomic spectra; - know about the origin of the fine structure in atomic spectra. - understand the exchange degeneracy and how it affects the excited states of helium, the derivation and the possibility of applying the selection rules for the interaction of electric dipole radiation and atoms; - apply time-dependent perturbation theory to simple cases. - understand the periodic table from the point of view of the electronic structure; - understand the time-independent perturbation theory, including its derivation, and be able to apply it to simple systems, including the Stark and Zeeman effects; - solve problems in atomic physics.
BD	Computer Simulations **2 credits** Prerequisites: Mathematics 1,2, Analytical	*Course objective.* Computer simulation is a practical, elective course, which is aimed at the studying of contemporary programming languages, experimental data processing and numerical simulation of the physics experiment by the 2-nd year, bachelor degree students.	- understand and apply modern programming languages, processing experimental data and numerical modeling of a physical experiment; - practice numerical methods for solving ordinary differential equations; - develop the Verlet algorithm, the Picard iterative

	Geometry, Mechanics and molecular physics	It is about the basic ccontemporary programming languages, experimental data processing and numerical simulation of the physics experiment, Matlab IDE etc. The knowledge of the programming languages includes algorithms, variables and basic structures and functions in C++ , Matlab and other languages. It gives the working knowledge of the numerical methods for solving ordinary differential equations including Picard iterative process, Modified Euler's method, Predictor-corrector method, Leap-frog method and Euler-Cromer algorithm for solving ODE. It is studying the elements if Nonlinear differential equations, Stability of their numerical solution as well as the Types of equations that could be reduced to the system of differential equations. It is studying from numerical point of view the Fourier series, Fourier transform and Fourier series of some special functions etc.	process, the modified Euler method, the predictor-corrector method. The frog jumping method and the Euler-Cromer algorithm for solving an ODE; - format and write data to a file or other streams; - apply numerical methods for solving nonlinear differential equations; - investigate the stability of their numerical solution; - distinguish types of equations that can be reduced to a system of differential equations; - apply numerical integration, including trapezoidal formulas and rectangle methods, Simpson's rule, Monte Carlo methods, etc; - demonstrate practical knowledge of Newton and Lagrange interpolation polynomials and other methods of interpolation and extrapolation; - interpret and evaluate the results of their training within the course of the course and its individual modules, to be confident in the presentation of the material at the intermediate and final attestation; - perceive and critically evaluate the process of solving numerical scientific problems and anticipate its result; - carry out a thorough and competent analysis of the results of their studies, summarize the main ideas and ideas of the discipline through scientific essays, projects of scientific programming and code, etc .; - participate in educational and social interaction within the group and the educational environment

			created for listening to the discipline; - accept and analyze the problem posed, perceive its importance and anticipate a numerical decision, accept criticism and be able to criticize, work in a team; - appreciate the role of the course in the implementation of the global goals of the individual learning path.
BD	Probabilities theory **2 credits** Prerequisites: Mathematics 1,2, Analytical Geometry	A subject of probability theory is a mathematical analysis of random phenomena. Random phenomena is an empirical phenomena which (when a certain set of conditions) can be characterized by that - it doesn't have determinate stability (supervisions above it don't always result in the same outcomes); - it has a statistical stability (shown in statistical stability of frequencies).	- apply acquired knowledge of probability theory and its understanding (random event, probability definitions, basic probability formulas, independent research, random variables, etc.); - demonstrate an understanding of the general structure of the probability theory field and the relationship between its elements; - include new knowledge in the context of basic knowledge, interpret its content; - analyze the situation in the field of education and suggest the direction of its solution (research, calculation, analysis, etc.) inherent in the field of theoretical and probabilistic research individually or in group educational and research activities; - synthesize, interpret and evaluate the results of the theory of probability, modules, average exam level; - analyze the dynamics of solving scientific problems of probability theory (scientific reviews of specific problem studies).

BD	Basics of materials science **2 credits** Prerequisites: Physics 1, 2, Mechanics and molecular physics	Course objective: The program of the course is designed so that the training of a specialist with a broad outlook, deep knowledge in various areas of scientific and technological progress, able to solve basic issues of engineering activity was achieved with minimal costs, determine the purpose of this discipline. The ability to use the knowledge gained about the structure of matter and related sciences when studying this course, to deeply understand the essence of the main types of processing technology and the physics of phenomena arising from the effects of mechanical stress and powerful ionizing radiation fluxes that determine the student's competence to solve specific problems of various levels of design complexity and materials science, define the objectives of the discipline.	In accordance with the training module, students will gain profound systemic knowledge suitable for a critical assessment of the current state of materials science, its development trends, the successful accumulation of new scientific factual materials, and the possibility of developing their abilities in developing and using them in materials science. In the course of mastering this course, students are given the opportunity to get acquainted with many new theoretical and practical achievements, which will allow them to independently expand and accumulate new knowledge in this field.
BD	Circuitry of measuring devices **2 credits** Prerequisites: Mechanics and molecular physics, Basics of materials science	Course objective: Understanding the basics of electronic measurements that are prerequisite for study of more sophisticated systems such as automatic measurement and control .Understanding the requirements to generate electronic signals . Discussing different techniques to stabilize strength and frequency. Understanding different techniques to measure and calibrate frequency.	- To form students' knowledge of the principles of operation, parameters and features of the main classes of modern semiconductor devices and integrated circuits and operating modes, the basic principles of the analog electronic device (AED) circuit technology and methods for analyzing them, as well as the skills to select and build AED nodes; - explore measurement technologies that combine a combination of methods, approaches, software and logical support for the organization of measurements; conditions and trends in the development of measuring instruments and basic

			methods for measuring the characteristics of electronic circuits and signals and assessing their accuracy.
BD	Basics of automation **2 credits** Prerequisites: Basics of electronics, Mathematics 1,2, Analytical Geometry, Computer Simulations	*Course objective.* Basics of automation studies the various applications of the automatic control systems in electronics, engineering systems, research and production environment and devices, with use in radiolocation, radio navigation, radio control and radio communication etc. by the 2-nd year, bachelor degree students. The class is focused on the principles of action and reaction, methods of constructing and studying of various systems and individual technical tools and methods of automation. These includes the following: Impulse devices. Parameters and characteristics of the pulse and transient signals. Linear elements for the pulse regime devises. Transistor switches; Switches Symmetric and asymmetric. Blocking oscillators. The generator of linearly varying voltage. The stabilizing generator of linearly varying voltage; Comparator instrument. Discriminators for the selectors for pulse signals. Boolean and other logical functions. MOSFET gates and Constructing complex logical gates and devices and Synthesis of incompletely specified logical functions. Synthesis of Logic Devices with Multiple Outputs; Number systems. Performing arithmetic operations. Integrated logic circuit. Encoders, decoders, code converters. Multiplexing	- form the principles of action and feedback, methods for constructing and studying various systems and individual technical means and methods of automation; - analyze the automatic control system and select the main automation devices; - theoretically, consider and implement the basic idea of automated and automated control, types of automation systems, features and importance of automation of agricultural production, the synthesis of automatic control systems; - interpret and evaluate the learning outcomes of the course and its individual modules, to be confident when faced with the specific mid-term and final exam content; - participate in educational and social interaction within the group and the educational environment created for this course; - propose and analyze a problem, perceive its importance and foresee a numerical decision, accept criticism and be able to criticize, work in a team.

		and demultiplexing switches. Programmable Logical Matrix of elements. Addressing register implementations and Electronic counters. Adders. Analog-to-digital converters. Electronic storage gates and circuits. Digital circuitry control devices. Digital circuitry control devices schematics and design software. Computers. Basic architecture and operation principles. Linear and parallel computations paradigms. CPUs and their architectures. Input-Output interfaces and devices. External storage devices.	
BD	Nuclear physics **4 credits** Prerequisites: Mathematics. Mechanics and molecular physics. Physics 1, Physics 2, Atomic Physics.	*Course objective.* The purpose of the course "Nuclear Physics" is the acquisition of knowledge, skills and skills from the field of nuclear physics, necessary for scientific, research, design, technological and production activities. The course gives thorough theoretical and experimental knowledge on atomic nucleus, production of radioactive nuclei and decay and gives a good base for further studies in nuclear and radiation physics and within the field of nuclear energy.	- understand the structure of the atomic nucleus; - distinguish between types and patterns of radioactive decay; - calculate effective cross sections and use methods of their measurement; - explain the laws of radiation passing through a substance; - understand the mechanisms of nuclear reactions and their types; - apply the properties of nuclei and nuclear radiation in science and technology; - understand the basic laws of fission and nuclear fusion. - use this knowledge in practice; - carry out assessments and engineering calculations of the results of nuclear transformations; - work with nuclear-physical equipment;

			- apply the basic research methods of nuclear physics; - use sources and detectors of nuclear radiation.
BD	Designing of devices on FPGA **4 credits** Prerequisites: Basics of Electronics, Computer science, Integral and microprocessor circuitry, Computer Simulations, Circuitry of measuring devices, Basics of automation	*Course objective.* Familiarizing students with the theoretical and experimental foundations of programming digital devices, mastering the basic methods of programming complex digital circuits, and teaching how to implement these methods in practice using Xillinx integrated circuits.	- understand the fundamental concepts and syntax of the Verilog programming language; - apply theoretical and practical information about the basic principles of FPGA programming and task options for the main sections of programming and design, as well as tasks that require logical reflection for students to complete laboratory and independent work; - develop and understand the concept and basic functionality of modern programmable logic integrated circuits; - apply knowledge to solve various physical and technical problems.
BD	Theory of measurements **2 credits** Prerequisites: Analytical geometry,	*Course objective.* The purpose of the discipline is to provide students with theoretical knowledge and practical skills on the basics of the general theory of measurements, methods for ensuring the uniformity of measurements, the means to achieve the required accuracy of measurements and the processing of	- measure temperature by thermoelectric and thermoresistive, thermomagnetic and pyrometric methods; - develop a generalized block diagram of measuring and control devices; - explain the metrological characteristics of

	Mathematics, Physics, Probability theory	measurement results. Familiarization with typical measuring instruments and methods of processing measurements. Study of techniques and skills of choosing a technique and measuring specific scales of physical quantities with the minimum possible errors.	measuring and control devices; - classify physical quantities, measurement errors; - distinguish between measurement and control instruments with mechanical, optical, optical-mechanical, pneumatic and radioactive transducers; - demonstrate measurement and control of thermal quantities, electrical and magnetic quantities, optical and acoustic quantities; - apply methods and means of measuring and regulating temperature, measuring pressure, quantity and flow of gases and liquids; - verify the measurement and control; - understand the principles of the measurement process, the metrological characteristics and modes of operation of measuring devices, ensuring the uniformity of measurements, issues of potential measurement accuracy; - optimize the experiment of measurements in various conditions of measurement and environmental exposure; - perform operations with various types of measurement information; - apply practical skills of general measurement theory for experimental solution of the simplest tasks; - choose measuring instruments in accordance with the required accuracy of the measurement result; - methodically correctly carry out measurements of typical physical quantities and process

			measurement results.
BD	Dosimetry and protection from radiation **3 credits** Prerequisites: Nuclear Physics, Atomic Physics, Theory of measurements	*Course objective.* The goal of the course: is to familiarize students with the basic concepts of dosimetry, and protection from radioactive sources of natural and technogenic origin, as well as methods for calculating protection from ionizing radiation. To practice evidence-based methods of organizing workplaces in accordance with the norms of general and special safety precautions. Experimentally determine the alpha, beta and gamma background both indoors and in the open atmosphere. To be able to localize and eliminate the consequences of radiation accidents at various levels. To have knowledge of objective laws of physical processes in micro scale; and about methods of recording of ionizing radiation. To know ways and means of measuring and quantifying radiation Main types of interaction between neutrons and materials, their characteristics, methods of observation and experimental research.	- understand the basic concepts of dosimetry and sources of radioactive radiation; - explain the relationship of the nuclear-physical mechanisms of interaction of ionizing radiation with a biological substance; - apply fundamental knowledge of the laws of nuclear physics, in particular, in experimental and theoretical methods for calculating protection against ionizing radiation.
BD	Statistical analysis and interpretation of nuclear physics experiments data **3 credits** Prerequisites: Mathematics 1,2;	*Course objective.* Statistical analysis and interpretation of nuclear physics experiments is a practical elective course aimed at the training of application of modern statistical analysis for nuclear physics experiment. The course consists of two main parts: theoretical introduction in basics of statistics and practical part focused on solving statistical problems with modern	- understand statistical distributions, their concepts and applications, histogram basics, maximum similarity method, chi-square distribution, installation of frequent and Bayesian approaches, basics of ROOT structure - justify various fitting approaches; - use the installation with a ROOT card; - understand the differences between statistical

	Analytical geometry, Nuclear physics, Computer science, Computer simulation, Probability theory	software. The course give introduction and practical application of ROOT, a software framework developed for the data analysis of particle experiments in CERN. The main statistical techniques are studied in application to real data analysis with ROOT libraries. The main objectives are one and multidimensional fitting, multivariate analysis, histogramming and plotting of data.	distributions and the ability to apply a proper distribution; - fit models to observations using different methods: maximum probability, chi –square; - apply frequency and Bayesian approaches to testing hypotheses; - apply ROOT structures to analyze experimental data in nuclear physics: fitting, multidimensional analysis, data storage and recovery.
BD	Detectors of nuclear radiation **4 credits** Prerequisites: Atomic Physics, Nuclear Physics,	Course objective is introduce students to various types of detectors used to measure high-energy (ionizing) radiations, the electronic systems used to count and measure high-energy radiations, and the general properties of radiation detection systems.	- distinguish between the types and characteristics of detectors for high-energy radiation, how they work, and how they are used; - classify the types of detectors include: gas-filled detectors: simple ionization chambers, proportional, Geiger-Muller counters; - classify semiconductor detectors: pn-junction, lithium drift, high-purity germanium; - compare scintillation detectors: NaI (Tl), organic; - use electronic systems to detect and measure radiation; - substantiate the characteristics and use of nuclear detectors and calculate their property (efficiency, energy resolution, temporal resolution, resolution of a pair of pulses, dead time); - compare the properties of different detectors and select the detector that is most suitable for this application; - describe qualitatively and quantitatively the measurement result of a certain radiation using a

			specific radiation detection system; - organize and carry out independent research work (dissertation) in the field of nuclear physics and nuclear physics and elementary particles; - explain the mechanism of nuclear physical processes; - prepare reports that briefly describe laboratory experiments, present and analyze results, including experimental, calculated and common uncertainties, and draw conclusions based on the results obtained, as well as give oral presentations to the group.
BD	Interaction of Radiation With Matter **3 credits** Prerequisites: Physics 1,2, Mathematics 1,2, Atomic Physics, Nuclear Physics	The goal of the course is to familiarize students with the main effects and phenomena arising from the interaction of ions, gamma quanta, neutrons and electrons with matter atoms.	- understand the basic concepts and mechanisms of interaction of radiation with matter; - determine the processes occurring during the interaction of accelerated charged particles, neutrons and gamma quanta with atoms and nuclei of atoms of matter; - apply fundamental knowledge of the laws of quantum physics, in particular, in experimental and theoretical studies in the field of interaction of various types of radiation with atoms and nuclei of atoms of matter; - use the studied laws to understand the physics of cosmic rays, nuclear decays in the Earth's lithosphere and the radiation processes occurring in living matter; - formulate knowledge during presentations at scientific conferences and seminars on the physical understanding of the results obtained in the

			framework of the transition from classical physical to quantum concepts; - demonstrate the ability to collect, analyze and systematize experimental and theoretical data on the spectra of nuclear radiation and the spectra of ionizing radiation transmitted through various substances; - suggest methods for processing and recording energy losses due to ionizing radiation in various media and substances and formulate the mathematical patterns mathematically; - demonstrate skills in the study of new areas of the physics of the microworld, including ion-ion collisions and collisions of elementary particles. To be able to realize the need to improve the quality of equipment, computers and software used in experiments on nuclear physics installations and in the field; - determine the global trends of theoretical and practical development of nuclear physics in the field of low and ultra-low energy, and in the field of high and ultra-high energies.
BD	Microcontrollers and their application **3 credits** Prerequisites: Computer science, Basics of	*Course objective.* The study of the architecture and command systems of microprocessors, the principle of organization of microprocessor systems, as well as the design of microprocessor technology based on microcontrollers.	- understand the architecture and command systems of microprocessors, the principle of organization of microprocessor systems, as well as the development of microprocessor technology based on microcontrollers; - use modern methods of developing modern microprocessor technology by selecting

	Electronics, Electrical Engineering, Circuitry of measuring devices		microcontrollers (microprocessors) and programming microprocessor devices using appropriate software and tool environments; - develop methods for programming microcontrollers and the development of specific microprocessor technology on their basis; - apply basic concepts and concepts of graphical programming in LabVIEW; - understand the concepts and basic functions of graphical programming in the LabVIEW environment; - apply the results obtained in solving various physical and technical problems; - put into practice the basic methods of programming microcontrollers; - develop hardware for digital devices; - design various devices based on microprocessors.
BD	Spectrometry **3 credits** Prerequisites: Mathematics. Probability theory. Basics of electronics. Atomic physics. Nuclear physics. Theory of measurements.	*Course objective.* Mastering the fundamental concepts, laws and theories of modern nuclear physics; formation of students in the scientific worldview and physical thinking; the development of a rich arsenal of tools that serve to record the radiation being studied; mastering modern skills in organizing and conducting an automated physical experiment. Spectrometry comprises several experimental techniques which are of ultimate importance for experimental nuclear physics and various applications as well. Lecture will be devoted to fundamentals of X- and gamma- ray,	- substantiate the basic methods and applications of nuclear spectrometry of gamma radiation, light and heavy charged particles, as well as neutrons; - determine the properties and characteristics of ionizing radiation, the main processes of interaction of charged particles, neutrons and photons with the matter of the detectors; - use physical methods of radiation detection; - explain the properties and characteristics of gamma radiation from radionuclide sources; - apply the methods of processing experimental data, evaluating experimental errors and calculating

		charged particle and neutron spectroscopy.	specific loads, methods of conducting radiometric and spectrometric measurements; - offer modern ways of using information and communication technologies in the chosen field of activity; - select and use high-quality recording equipment for conducting experiments in nuclear physics and environmental monitoring; - select high quality, make engineering calculations and design detectors of all types of emissions. - apply methods for processing experimental data, evaluating experimental errors and calculating the characteristics of the radiation source fields; - solve the problems of nuclear spectroscopy.
BD	Computer technologies in instrument making **3 credits** Prerequisites: Mathematics 1,2, Mechanics, Computer science, Basics of Electronics, Electrical Engineering	*Course objective.* Computer technologies in instrument making" is a practical, elective course, which is aimed at the studying the scientific and engineering component of instrument making using Matlab IDE by the bachelor degree students. The goal of the course: is to create and foster the knowledge of the integrated development environment required to understand and develop instrument making knowledge and skills. These knowledge and skills include but not limited to the: Matlab integrated development environment; Implemented ODEs solvers in Matlab. Predictor-corrector method and Leap-frog method graphical implementation; Nonlinear differential equations. Stability of numerical solution; Simulating	- implement the Matlab integrated development environment; - implement and apply the ODE solvers in Matlab; - apply the methods of predictor-corrector, "jump frog" and other methods for solving ODE; - solve nonlinear differential equations, study the stability of their numerical solution; - simulate the interaction between several particles in a limited space; - apply periodic boundary conditions; - study the characteristics of an ideal gas in three-dimensional space; - use interpolation and extrapolation; - use spatial Fourier filters, random numbers, pseudo-random number generators;

		interaction between the multiple particles in a confined space. Periodic boundary conditions. Ideal gas in 3-dimensional space. Interpolation and extrapolation; Fourier Spatial filters; Random numbers. Pseudorandom number generators; Area Estimates by Monte Carlo Simulation; A numerical calculation of the multidimensional integrals; Partial Differential Equations. Poisson equation;	- use methods for solving partial differential equations; - demonstrate acquired knowledge of the integrated development environment in the profession; - demonstrate an understanding of the general structure, procedures and key elements of programming languages and solving physical problems using numerical methods; - include new received information in the context of the design of nuclear, high energy devices; - analyze the complex situation of designing and manufacturing devices and devices and propose solutions to their tasks; - apply methods and tools such as Matalb, Simulink, mathematical analysis, visualization tools, etc. For various fields of nuclear physics and instrumentation.
	5. INDIVIDUAL EDUCATIONAL TRAJECTORIES		
M IET 1	Nuclear electronics **3 credits** Prerequisites:Methods of Nuclear Physics, Introduction to Nuclear Physics, Methods of Nuclear Physics,	Course objective: In experimental nuclear physics, electronic methods, instruments and automated systems are widely used. This is explained by the fact that in the selected studies, rapidly occurring statistically distributed in time and space events are studied and very large volumes of information are processed. The field of electronics associated with nuclear physics is usually called nuclear electronics. This course provides a systematic presentation of the main issues of modern nuclear electronics; it is	- distinguish between the types and characteristics of detectors for high-energy radiation, how they work and how they are used; - compare types of detectors include: gas-filled detectors: simple ionization chambers, proportional, Geiger-Muller counters; - compare semiconductor detectors: pn-junction, lithium drift, high-purity germanium; - compare scintillation detectors: NaI (Tl), organic, electronic systems for detecting and measuring

	Detectors of Nuclear Radiation	intended for students specializing in the field of experimental nuclear physics.	radiation. - process analog and digital signals; - justify the characteristics and structure of amplifiers; - classify logical elements on integrated circuits; - calculate the characteristics of nuclear detectors, their properties (efficiency, energy resolution, temporal resolution, resolution of a pair of pulses, dead time); - compare the properties of different detectors and select the detector that is most suitable for this application; - describe qualitatively and quantitatively the measurement result of a certain radiation using a specific radiation detection system; - use in practice methods to remove the signal from the radiation detector; - process analog and digital signals; - experimentally determine the noise levels; - read and understand schematic diagrams; - explain the mechanisms of nuclear physical processes; - prepare reports that briefly describe laboratory experiments, present and analyze results, including experimental, calculated and common uncertainties, and draw conclusions based on the results obtained, as well as give oral presentations to the group.
M IET	Simulation of nuclear physics	*Course objective.* To study the basic concepts of the GEANT4	- learn the basic concepts of the simulation package in GEANT4, how to change the input parameters of

1	setups **3 credits** Prerequisites: Mathematics 1,2; Nuclear physics, Computer science, Computer simulation, Probability theory	modeling package, how to change the input parameters of the simulation and learn to work with the g ++ compiler (GNU c ++ compiler).	the simulation and learn how to work with the g ++ compiler (GNU c ++ compiler); - read the basic commands of the bash command console, Midnight Commander Linux file manager; - read the installation procedure for the GEANT4 modeling package on Linux and Windows platforms, with viewing of DeepExploration viewer VRML files; - design materials in GEANT4, adjust the geometry of the installation and obtain the energy spectrum of the radiation with this equipment line shape (AFL); - connect the magnetic field in GEANT4 and control with the help of particle beams, optical processes in GEANT4 (scintillation, cutting, absorption and scattering of light); - install a non-monoenergetic source in GEANT4; - obtain time spectra in GEANT4; - build geometry with repeating elements in GEANT4; - apply the standard (embedded) PhysicsList set in GEANT4; - simulate calorimeter in GEANT4.
M IET 1	Instrument making in advanced nuclear physics experiments **3 credits**	*Course objective.* Instrument making in advanced nuclear physics experiments is a practical elective course aimed at the studying of the modern approaches used in design, development and implementation of the advanced nuclear, particle and astroparticle physics	- understand the principles of operation of individual detectors and the entire range of courses; - analyze all advanced global research; - describe the natural-scientific nature of the problems arising in the course of professional activity, involve the physical and mathematical

	Prerequisites: Mathematics 1,2; Nuclear electronics, Detectors of nuclear radiation	experiments. The detectors used in these experiments as well as technologies for the data acquisition is overviewed in the present course. The course provides basic knowledges on particle detection such as using of PMTs, scintillators and radio antennas. The modern data acquisition is given, particularly, FADC and FPGA. The exercised based on the simple data analysis of the modern astroparticle instruments are included in the course.	apparatus to solve them; - explain the technological processes of production, metrological assurance and quality control of elements of devices for various purposes, the main stages and laws of the historical development of society; - search, store, process and analyze information from various sources and databases, present it in the required format using information, computer and network technologies. - analyze the task of research in the field of instrumentation; - Mathematically simulate the processes and objects of instrumentation and their research based on standard computer-aided design packages and independently developed software products that measure and study various objects in accordance with this method; - develop project and technological work plans and monitor their implementation, including providing relevant services with the necessary technical documentation, materials and equipment; - to develop optimal solutions for the creation of instrument-making products taking into account the requirements of quality, cost, execution time, competitiveness and life safety, as well as environmental safety; - establish the order of execution of works and the organization of routes for technological passage of

			elements and components of devices and systems in the process of their manufacture.
M IET 1	Basics of Python programming language **3 credits** Prerequisites: Mathematics 1,2, Computer science, Computer simulation, Probability theory	*Course objective.* Basics of Python programming language is a practical elective course aimed at the training of programming skills with Python language and its scientific libraries. Most of the branches of modern science and industry use Python applications for data analysis, processing and mining, statistical analysis, simulations and data visualization. The proposed course covers all these disciplines and gives a basic and practical knowledge of Python tools used there. The course overviews existing libraries and provides practical exercises on working with them.	- explain the basic principles of programming Python, understanding the syntax of the language; - distinguish features of Python and programming patterns; - use the modern library python to analyze scientific data: numpy, scipy, matplotlib; - analyze the main scientific data: statistics, construction, installation; - conduct advanced analysis of data from specific experiments; - practice linking Python to C/C++ languages; - use the features of working with a graphical user interface with Python, work with the HDF5 data format; - develop programs and scripts in Python languages; - understand and apply modern Python template, if necessary; - perform basic and advanced data analysis of a physical experiment using existing Python libraries; - justify linking Python with external libraries written in C/C++ programming languages; - develop and implement a graphical user interface for Python programs and templates; - create file databases and data warehouse deployment using the HDF5 file format.

M IET 1	Technology of designing devices and systems **3 credits** Prerequisites: Mathematics 1,2, Physics 1,2, Computer science, Computer simulation Basics of Electronics, Electrical Engineering	*Course objective.* “Technology of designing devices and systems” is a practical, elective course, which is aimed at the studying the contemporary methods of the instrument and devices design and production by bachelor degree students. The goal of the course: is to create and foster the knowledge of the contemporary technology of designing devices and systems, as well as theoretical and programming skills required to understand and use them in your research area. These knowledge and skills include but not limited to the: The block-hierarchical approach. Functional design of the measuring device. Principles of construction of instruments and systems. Development of a mathematical model of a measuring device. Mathematical model of the device for static measurement mode. Static characteristics of the measuring device. Dynamic characteristics of the measuring device. Types of dynamic characteristics of the measuring device. Synthesis of the parameters of the calculated static characteristic of the measuring device. Characteristics of deterministic signals. Energy characteristics. Spectral characteristics. Analysis of the accuracy of the measuring device. Calculation of additive interference. Fundamentals of reliability of measuring devices. Types of performance characteristics of measuring devices. Organization of scientific research works. AutoCAD's User	- predict and design the life cycle of the measuring device; - implement a functional design of the measuring device; - develop a mathematical model of the measuring device; - calculate the sensitivity coefficient of the measuring device; - calculate the error of the nonlinearity of the static characteristics of the measuring device; - control the dynamic characteristics of the measuring device; - analyze the accuracy of the measuring device; - use measurement error equations; - calculate additive interference and total errors; - compare the types of performance of measuring instruments; - demonstrate the acquired knowledge in the field of instrumentation and design in the professional field; - demonstrate an understanding of the overall structure, procedures and key elements of the toolkit and design, applying it to the problems of real life; - include new received information in the context of nuclear physics and high energy physics and rethink its content based on this information; - analyze the complex situation of designing and manufacturing instruments and devices and propose

		Interface. AutoCAD's Cartesian Workspace. Modifying an Existing Drawing File. Selecting Objects for Editing. Moving Objects. Copying Objects. Rotating Objects. Scaling Objects. Mirroring Objects.	solutions to their tasks; - apply methods and tools such as AutoCAD, numerical modeling, mathematical analysis, visualization tools, etc. for various fields of nuclear physics and instrument engineering.
M IET 1	Computerized tomography methods **3 credits** Prerequisites: General mathematics courses, differential equations. Mechanics, Optics, Electricity courses in Physics	*Course objective.* "Computerized tomography methods" is a practical, elective course, which is aimed at the studying of the revolutionary noninvasive cross-sectional imaging of an object from either transmission or reflection data collected by illuminating the object from many different directions. by the 4-th year, bachelor degree students. The goal of the course: is to create and foster the knowledge of the contemporary medical imaging modalities in general and computer tomography in particular, as well as theoretical and programming skills required to understand and use them in your research area. These knowledge and skills include but not limited to the: Signal Processing Fundamentals and Fourier Representation. Algorithms for Reconstruction with Nondiffracting Sources. Line Integrals and Projections. The Fourier Slice Theorem. Three-Dimensional Filtered Backprojection; X-Ray Tomography. Monochromatic X-Ray Projections. Measurement of Projection Data with Polychromatic Sources; Ultrasonic Computed Tomography. Magnetic Resonance Imaging; Noise	- process signals; - understand and apply one-dimensional signal processing, continuous and discrete one-dimensional functions, linear operations in the Fourier transform view, discrete Fourier transform (DFT), truncated Fourier transform, data truncation effects; - process images in frequency space, turned sources and delta functions, invariant operations, linear shift and Fourier analysis; - implement recovery algorithms with coherent sources, reconstruction algorithms in parallel beams, three-dimensional back projection algorithms; - determine the noise and artifacts in computed tomography; - minimize noise and optimize the conditions for recording and restoring images in CT, sampling in real systems; - solve the inhomogeneous wave equation, approximation to the wave equation; - use the approximate primary approximation and the first Rytov approximation; - implement algorithms of algebraic reconstruction;

		in Reconstructed Images. Homogeneous Wave Equation; Inhomogeneous Wave Equation. Approximations to the Wave Equation. The Fourier Diffraction Theorem. Decomposing the Green's Function. Fourier Transform Approach; Interpolation and a Filtered Backpropagation Algorithm for Diffracting Sources. Frequency Domain Interpolation; Algebraic Reconstruction Algorithms. Image and Projection Representation. ART (Algebraic Reconstruction Techniques); SIRT (Simultaneous Iterative Reconstructive Technique). SART (Simultaneous Algebraic Reconstruction Technique).	- illustrate the image and projection representation, ART (methods of algebraic reconstruction); - apply SIRT (Simultaneous Iterative Reconstructive Technique), SART (Simultaneous Algebraic Reconstruction Method), simulation of the direct projection process, implementation of the reconstruction algorithm; - demonstrate acquired knowledge of medical imaging techniques; - understand the general structure and key elements of the course of computed tomography and its relationship with nuclear physics; - include new received information in the context of knowledge about nuclear physics and qualitatively rethink its content; - analyze the complex research situation and be able to propose solutions to the tasks with the use of computational tools and tools provided by the discipline; - apply various methods of visualizing the structure of an object in science and medicine, computational physics, numerical modeling, mathematical analysis, visualization tools, etc. for various fields of nuclear physics, science and medicine.
M IET 1	Automation of acquiring data from coordinate-sensitive and track detectors	*Course objective.* In many studies in experimental nuclear physics, the spatial distributions of particles or quanta and the trajectory of particle motion are studied. In comparatively simple experiments, for example, using a magnetic alpha spectrometer, the	- understand the properties and characteristics of ionizing radiation, the main processes of interaction of charged particles, neutrons and photons with the matter of the detectors; - use physical methods of radiation registration;

	3 credits Prerequisites: Detectors of nuclear radiation; Automation of experimental data processing methods; Basics of electronics; Electrical Engineering	particle distribution along one coordinate is measured. In more complex studies, such distributions are studied in the plane and space. The introduction of automatic information retrieval significantly reduces the time required for the processing of results, improves the accuracy of measurements, makes it possible to isolate events of interest. Coordinate-sensitive detectors have been created to determine the coordinates of particles and quanta. Some of them are the further development of gas-discharge, semiconductor and scintillation detectors, others are based on the use of discrete detection structures and channel multiplication plates. These detectors require special electronic methods for signal removal and coordinate coding. Very important is the automation and when processing photos of tracks obtained on bubble or spark chambers. In many studies it is necessary to process tens of thousands of photographs. Therefore, readers should have high speed. Therefore, in addition to special optical-mechanical systems, television methods are used, as well as devices with electron-optical converters.	- interpret the properties and characteristics of gamma radiation from radionuclide sources; - apply methods for processing experimental data, evaluating experimental errors and calculating the characteristics of radiation fields; - justify the principles of operation, characteristics and capabilities of various electronic devices that allow you to analyze the signal from the detectors used in the experiment; - select and use high-quality recording equipment for conducting experiments in nuclear physics and environmental monitoring; - select high quality, make engineering calculations and design detectors of all types of emissions; - apply the methods of processing experimental data, estimating the experimental errors and calculating the characteristics of the radiation source fields; - apply methods of radiometric and spectrometric measurements; - use online resources in the course of research, including in a foreign language.
M IET 1	Multiparameter and correlation measurements **3 credits** Prerequisites:	*Course objective.* In experimental nuclear physics, it is often necessary to investigate complex distributions, depending on a large number of parameters. For example, in gamma spectrometry, in the study of cascade transitions, 7 quanta from two	- distinguish features of measurement of complex distributions; - possess coding information in multiparameter analyzers; - apply information coding from several detectors;

	Nuclear Electronics, Detectors of nuclear radiation, Theory of measurements, Basics of automation	detectors are simultaneously recorded and they are looking for distributions from two amplitude values $n=f(A_1A_2)$. In neutron spectrometry, the time of flight is studied, for example, γ-quanta from the neutron capture reaction, while measurements are conducted by a large number of detectors and determine the distribution depending on the time of flight of neutrons, energy of γ-quanta, detector number $n=f(t,A,K_1)$ etc. To carry out such measurements, multi-pair analyzers and computer systems are used. This course aim is to teach the students to work with the instruments for complex multiparameter and correlation measurements.	- describe associative systems and preliminary selection of information; - describe multiparameter systems with mass memory; - justify the averaging of correlators, correlation time-of-flight spectrometers; - encode information in multiparameter analyzers; - encode information from several detectors; - apply the correlation method in neutron spectrometry; - generate pseudo-random pulses; - conduct a multiparameter experiment.
M IET 1	Devices for non-destructive testing **3 credits** Prerequisites: Occupational Safety and Health, Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics.	*Course objective.* This course provides students a synopsis of non-destructive and destructive evaluation methods that are used in evaluation of welds. This includes understanding the basic principles of various NDT methods, fundamentals, discontinuities in different product forms, importance of NDT, applications, limitations of NDT methods and techniques and codes, standards and specifications related to non-destructive testing technology. Students also will be introduced to relevant quality assurance and quality control requirements in accordance with ASQ, ASME, and ANSI standards.	- explain why non-destructive testing methods were developed; - describe the use of NDT; - explain each method of non-destructive testing; - describe the benefits and limitations of VT; - determine the purpose of welding and symbols NDE; - apply the six basic steps for the PT; - describe the basic principles of MK; - compare the types of radioactive sources used for the RT; - apply such basic concepts as visual testing, symbols of welding, liquid-penetrant testing, magnetic particle testing, radiation testing, ultrasonic testing; - list and identify various defects arising during

			welding, shown in the process of non-destructive testing/destructive testing; - determine the types of equipment used for each non-destructive and destructive testing; - explain the purpose of the equipment, application and standard methods necessary for conducting serious non-destructive and destructive testingof welds; - go to a specific code, standard, or specification regarding each testingmethod; - determine the strengths and weaknesses of the materials used in the manufacture.
M IET 2	Medical physics **3 credits** Prerequisites: Occupational Safety and Health, Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics, Detectors of nuclear radiation	*Course objective.* This course analyzes the human body from the basic principles of physics. Principles derived in physics are applied directly to the human body. 1. To describe effects of heat and cold in medicine, and energy metabolism in human body. 2. To describe effects of physics of lung and breathing mechanism. 3. To discuss the pumping action of the heart and how the blood pressure changes occur. 4. To discuss the electrical conduction system of the nerves in the brain, the heart and the eyes, application of low and high frequency electricity in medicine, magnetism in medicine 5. To discuss how the ultrasound is helpful in	- understand how the mechanisms of the human body are connected with the fundamental concepts of physics; - use heat and cold in medicine; - apply the physics of the lungs and respiration, the physics of the cardiovascular system, electricity within the body, the theory of sounds and light in medicine; - apply heat and cold for diagnostic and therapeutic purposes; - apply the theory of sound and light for diagnostic and therapeutic purposes; - offer a suitable system depending on the state of the body.

		Medicine, physics of ear and hearing to know about how light is helpful in Medicine.	
M IET 2	Medical instruments and medical engineering **3 credits** Prerequisites: Occupational Safety and Health, Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics, Detectors of nuclear radiation, Interaction of Radiation With Matter, Dosimetry and protection from radiation	*Course objective:* 1. To learn the nature of various physiological signals . 2. To learn about the measurement of blood pressure, pulse rate etc. and cardiac pacemakers & defibrillators 3. To learn basics of auditory mechanisms and the hearing aids. 4. To learn the basics of surgical systems. 5. To learn the medical imaging modalities such as ultrasonic and MRI.	- formulate a basic medical measuring system, requirements for the effectiveness of medical measuring systems; - justify the general limitations in the design of medical measuring systems; - interpret a typical biomedical measuring system, its limitations and precautions; - understand the origin of biomedical signals and sensory mechanisms; - apply the principles of audiometers, ventilators, hemodialysis, etc. for the development of new models; - understand the fundamental results of ultrasonic imaging and magnetic resonance imaging.

M IET 2	Clinical engineering **3 credits** Prerequisites: Occupational Safety and Health, Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics, Detectors of nuclear radiation, Interaction of Radiation With Matter, Dosimetry and protection from radiation	*Course objective:* To make the student 1. To understand the role of clinical engineer and importance of clinical engineering. 2. To learn the hospital managerial skills in all aspects. 3. The routine maintenance safety and other issues of medical devices.	- understand the role of clinical engineering in the organization of the hospital. - determine the main functions of the clinical engineering department; - troubleshoot medical devices, safety standards and rules; - manage health care; - maintain safety standards in the clinical environment; - determine the standards for maintenance and repair of medical devices, as well as research and design of medical devices.
M IET 2	Medical electronics **3 credits** Prerequisites: Occupational Safety and Health,	*Course objective:* The student will understand 1. The transducer principle, type, measurement of physiological parameter 2. The bio signal measurement 3. Analytical instruments such as colorimeter, pH meter	- distinguish types of medical devices; - understand medical information and their use in the diagnostic process; - use analytical instruments, such as a colorimeter, pH meter; - apply and maintain medical equipment such as x-

	Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics, Detectors of nuclear radiation, Interaction of Radiation With Matter, Dosimetry and protection from radiation	4. Medical Instrumentation such as X- ray, Ultrasound, Recorders	ray, ultrasound, recorders; - apply biomedical electronics; - measure physiological parameters; - practice medical and work tools; - read and interpret technical documents, express ideas and speak clearly; - prepare technical documentation.
M IET 2	Medical imaging systems **3 credits** Prerequisites: Occupational Safety and Health, Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics, Detectors of	*Course objective:* 1. To understand fundamentals of x-ray and its generation and biological effects. 2. To study different x-ray diagnostic methods. 3. To study CT imaging concepts, fundamental of Magnetic resonance imaging.. 4. To study fundamentals of ultrasound and working different ultrasound techniques. 5. To study the principles of Radionuclide imaging.	- classify various imaging methods, such as x-rays, CT, ultrasound and MRI; - use medical equipment such as x-ray, ultrasound, recorders; - determine the standard of communication of medical images; - promote visualization techniques; - develop image reconstruction from the above described visualization methods using various transformations; - study the latest trends and events; - interpret technical documents; - prepare technical documentation.

	nuclear radiation, Interaction of Radiation With Matter, Dosimetry and protection from radiation		
M IET 2	Biomedical equipments **3 credits** Prerequisites: Occupational Safety and Health, Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics, Detectors of nuclear radiation, Interaction of Radiation With Matter, Dosimetry and protection from radiation	*Course objective:* 1. To study spectrophotometer, clinical flame photometer. 2. To study different blood gas analyzers 3. To study different types of Audiometers 4. To understand the working principle of surgical diathermy. 5. To study hemodialysis and different ventilators	- distinguish biomedical equipment such as clinical trial equipment, blood gas analyzers, blood cell counters and surgical equipment; - describe clinical laboratory instruments, medical equipment, such as x-rays, ultrasound, recorders; - record and interpret the human hearing response; - offer a suitable hearing aid; - develop artificial organs such as the kidneys and lungs; - study the latest trends and events; - interpret regulatory and technical documents; - prepare regulatory and technical documentation.

M IET 2	Lasers and fiber optics in medicine **3 credits** Prerequisites: Occupational Safety and Health, Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics, Detectors of nuclear radiation, Interaction of Radiation With Matter, Dosimetry and protection from radiation	*Course objective:* 1. To study the production of lasers, its properties and types. 2. To study the effects of laser-tissue interaction. 3. To know the need for optic fibers and its applications in Medicine. 4. To gain knowledge regarding fiber fabrication and fiber bundles. 5. To study the basic principle of endoscopy, its uses in diagnosis and therapeutic field.	- classify various lasers and their applications in diagnostics and therapy; - understand the basics and principles of optical fibers; - describe and apply clinical laboratory instruments, medical equipment; - compare the various applications of fiber-optic laser in imaging systems; - analyze the latest trends and events.
M IET 2	Biosensors and smart sensors **3 credits** Prerequisites: Occupational Safety and Health, Physics 1,2,	*Course objective:* To study 1. The components used for various biosensors and biosensor family. 2. The principles of different types of transducers. 3. The applications of biosensor in different fields. 4. Different types of photometric assay techniques.	- classify various biosensors, transducers and their applications in diagnostics and therapy; - understand and apply the principles and principles of clinical laboratory devices; - develop and create medical equipment with biosensors; - analyze methods, such as amperometric and

	Basics of electronics, Atomic physics, Nuclear physics, Detectors of nuclear radiation, Interaction of Radiation With Matter, Dosimetry and protection from radiation		photometric analysis of bioassay based on luminescence; - analyze the latest trends and events; - interpret and prepare regulatory and technical documentation.
M IET 2	Biomedical digital signal processing **3 credits** Prerequisites: Mechanics and molecular physics, Physics 1,2, Basics of electronics, Atomic physics, Nuclear physics, Detectors of nuclear radiation, Interaction of Radiation With Matter,	*Course objective:* 1. To learn the nature of various biomedical signals and its analysis. 2. To know about neurological signal generation. 3. To study sleep EEG types and their features. 4. To study adaptive filters and their applications in biomedical signal processing. 5. To gain knowledge about various artefacts and methods to eliminate it. 6. To study cardiological signal processing	- describe the nature of the biomedical signal; - justify the characteristics and analysis of the EMG signal; - classify various biosensors, transducers and their applications in diagnostics and therapy; - apply the principles and principles of clinical laboratory devices; - to classify deviations from various physiological signals; - analyze and interpret various biosignals; - develop various filters; - simulate physiological signals; - prepare technical documentation.

	Dosimetry and protection from radiation		
7. PRACTICE			
	Professional practice (by types of practice)		
	Educational Practice **1 credits**	The purpose of the educational practice is to train students to solve physical problems and to work with scientific publications. The practice is aimed at developing group efforts in solving complex problems as well as at sharpening student's own understanding by taking part in discussions with other students.	Strong self-working skills and ability to effectively work as a team member, engaged in solving non-standard physical problems
	Institutional Practice **5 credits**	The purpose of the institutional practice is to fix theoretical knowledge of basic and major cycles of disciplines and to get practical experience at a potential employer. During the practice training, preliminary data and information for bachelor degree project are collected. Students become familiar with technological, organizational and social aspects of institutions and companies; they study and analyze specialized technical literature, software and instruction manuals used in a particular institution or company.	Acquaintance with various aspects of professional activities and strong practical skills required by a potential employer.
	Pre-diploma Practice **4 credits**	The main purpose of the pre-diploma practice is to provide theoretical and practical results that are sufficient for a successful implementation and defence of the final thesis. The practice is designed to summarize students' results of an independent study and research on an	Ability to compile all gathered information and data, as well as the obtained results in a single manuscript written in an appropriate logical manner.

		actual problem, specific for the corresponding field of activity. The practice also consolidates all skills acquired in the course of all previous practices.	

CONLUSIONS OF EXPERTS

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Expert report on educational program "Instruments for nuclear and medical physics" developed for the Department of Physics and Technology of al-Farabi Kazakh National University

The educational program for specialization "Instruments for nuclear and medical physics" is developed for the 4-year bachelor course on the physical department at the al-Farabi Kazakh National University. The main feature of this program is the focus on the hardware and software technologies necessary for design and development of the modern instruments used in nuclear reactors, accelerators, medical applications. It is worth noting that the program has three well-balanced directions: basic physics and mathematics, electronics and software. Since the program is developed at the Department of Physics and Technology, the basic courses (general and nuclear physics, mathematics, statistics, etc) are fitted to the main direction of the program, e.g. many academical hours are dedicated for differential equations and statistical analysis. The training program for electronics development is based on the classical program on radiophysics with few important upgrades including courses related to computer design and simulation of hardware. The latest direction of the program, namely software and information technologies (IT), is of special interest, since the IT training course proposed in this program is very relevant to the requirements of the modern economics and industry. The overall program is aimed to train very competitive expert with broad knowledge on modern technologies. The basic and practical knowledge given in this program allow student to focus either on deep narrow specialization on development of particular parts of instruments or on full-stack hardware design from simulation to production.

To maximize the results of training the following comments and recommendations have to be taken into account:

1. Focus on practical exercises. There are significant amount of academical hours dedicated for practical and laboratory exercises. Usually there are lack of attention paid to

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such exercises. The developers of the program have to find sufficient resources to perform practical training on the proper level.

2. Being up-to-date on the modern IT technologies. Since computer science and IT are developing incredibly fast, it is very important to provide actual knowledge to the students. By this, the IT courses have to be updated every year. Probably it makes sense to invite experts in field for training students as well as staff at the faculty.

3. Participation of the students at the conferences and summer schools focused on computer science and information technologies. Although the program is developed on the Department of Physics and Technology, the developers have to consider such option.

Conclusion: The proposed educational program fulfills requirements for specialization "Instruments for nuclear and medical physics" completely. The integration of specialization into educational program of Department of Physics and Technology of al-Farabi Kazakh National University is strongly supported.

Expert
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Evaluation of the
Bachelor Educational Program
"Instrument making" by
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It is needless to say that the field of the nuclear and particle physics is one of the most important academic fields in the natural science. This is one of the main subjects in the physics, and also is the foundation of the various application/engineering fields. The nuclear engineering is one of them and it significantly relies on the field of the nuclear and particle physics.

The educational program of the instrument making in the field of nuclear physics in the Al-Farabi university is well organized, and it can be said that it is as advanced as those of the other world-wide universities. The educational program defines two competences, which are cultural competence (CC) and professional competence (PC). The CC covers understanding of the recent history of Kazakhstan, critical thinking/time management, English skills, Ethics, Laws and legal standard, team collaboration skill and social responsibility. Those are mandatory for students who will contribute to the future Kazakhstan society and to the world also. The PC consists of two parts, a specific professional competence and a general professional competence. Both are well organized and cover wide ranges of the competences required for young students.

It can be confirmed that the educational program of the instrument making during eight semesters can provides lectures and practices which can cover all the competencies. These lectures and practices include general education such as language skills, basic disciplines about mathematics and physics, and majors about the nuclear and particle physics. This educational program offers to students much knowledge and experiences enough to their future contributions to the society.

My conclusion is that this educational program of the instrument making is well organized, and it can be expected that promising students can be well educated under this program.

November 23, 2018

Go CHIBA

Hokkaido University

University of Jyväskylä
Department of Physics
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Jyväskylä, 9 November 2018

Evaluation of the

Educational Program at the AL-FARABI KAZAKH NATIONAL UNIVERSITY

Instruments for nuclear physics and medicine

Specialty 5B071600 - Instrument making

The main purpose of the Educational Program at the **AL-FARABI KAZAKH NATIONAL UNIVERSITY** entitled **Instruments for nuclear physics and medicine** is to prepare highly qualified specialists in the field of instruments for nuclear physics and medicine with profound knowledge and competences necessary for employment in industries and institutions with scientific, engineering and medical backgrounds.

I consider this goal extremally important and relevant. Nuclear science and technology have made positive impact of the world and it is essential that students benefit from this heritage and, if possible, progress to develop new instrumentation, both for the basic and applied science. I have personally devoted my scientific carrier to the development, implementation and use of the new instruments and methods in the fields of low-energy nuclear physics, relativistic heavy ion collisions, neutrino physics, and ultra-relativistic cosmic rays [https://www.jyu.fi/hendes]. The most significant is the new Fast Interaction Trigger for the upgrade of the ALICE experiment at the Large Hadron Collider at CERN [NIMA 845(2017)463]. My group is also involved in the utilization of the Pyhäsalmi mine for scientific purposes [https://arxiv.org/abs/1810.00909] including a novel approach to the acoustic detection of EeV neutrinos in the bedrock.

Kazakhstan has a reach tradition in nuclear physics and is also the host of the Tien Shan Astronomical Observatory – a great asset well worth of further development. I hope that the new Education Program will vitalize these important areas of research and help develop the use of the methods invented for the needs of basic science also for applications closer to the direct needs of the society. To illustrate the point, let me name just two examples: muon tomography and hadron therapy. The importance of the later is very well known. The former, applies detection techniques developed for particle and cosmic-ray studies for long-term monitoring of tunnels and caverns (safety), search for new ore deposits, detection of density variations, identification of rock weakness zones, and 3D rock imaging over the volume on the scale of cubic kilometer. In fact, muons have already been used for such purposes. The best known cases are the tomographic images of the Khufu's Pyramid in Egypt that have reviled a hidden chamber [Nature 522 (2017) 386] or the study of a volcano in Japan [Journal of Geophysical Research: Solid Earth 119 (2014) 699].

In conclusion, I strongly support implementation of the new Educational Program at the **AL-FARABI KAZAKH NATIONAL UNIVERSITY** entitled **Instruments for nuclear physics and medicine** and in particular Specialty 5B071600 - **Instrument making** and I make my expertise available to help in the realization and further development of the program.

W. Trzaska

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Review of

Educational Program in English "Instrument making"

at Al-Farabi Kazakh National University

by

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The Al-Farabi Kazakh National University (KNU) is planning to establish a new program, which is the Educational Program in English "Instrument making". I, Prof. Masayuki AIKAWA, Faculty of Science, Hokkaido University, reviewed the plan of the program.

The program is dedicated for "raising of highly qualified specialists in the field of instruments for nuclear physics and medicine" for professional activities. The aim of the program is to train students with "profound knowledge and competences necessary for employment in industries and institutions with scientific, engineering and medical backgrounds". In order to achieve the aim, the program defines the two types of competence, cultural and professional competence. The two types of competence are acquired by their modules as General Education, Basic Disciplines, Majors and so on. The modules can cover very wide range of skills and knowledge. Under the program, students will be able to obtain considerable skills and profound knowledge for professional activities.

Although the program is well defined as mentioned above, I dare to recommend to prepare clear curriculum map and model cases for individual goals. There are a variety of modules in the program and their expected results. Therefore, I am afraid that students may be confused for the selection of the modules. The information for the module selection can probably help each student.

In summary, the specialists in the field of nuclear physics and medicine are highly required worldwide and the Educational Program in English "Instrument making" at Al-Farabi Kazakh National University is well planned and valuable to be established.

November 28, 2018

Prof. Masayuki AIKAWA

合川 正幸

Istituto Nazionale di Fisica Nucleare
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Expert report on educational program "Instruments for nuclear and medical physics" developed for Department of Physics and Technology of al-Farabi Kazakh National University

The Department of Physics and Technology proposed the establishment of a four-year bachelor's course. One main peculiarity of this program is that the hours of practical and laboratory part corresponds to about 2/3 of those of the entire course of study.

In particular the program of software and hardware technologies is focused on the design and development of new instruments used in different fields of the modern research and technological development facilities for example in the nuclear medical application, in the nuclear accelerators and in nuclear reactors. To this purpose, demanding programs of studies in the area of hardware and software are planned for the design and development in these nuclear applications. This goal is quite achievable considering that the program will be developed in the Department of Physics and Technology. There are three lines of investment in teaching activities for the preparation of students for the acquisition of the notions essential for a high level of knowledge also of modern technologies. The first is the academic hours dedicated to basic courses, especially mathematics, physics (general, atomic and nuclear) and electronics. Many academic hours are dedicated for analysis mathematic in particular for the study of differential equations. The second of main feature in this program is that the hours of the practical and laboratory part corresponds to about 2/3 of entire course for the acquisition of the notions essential for a high level of knowledge also of modern technologies.
A careful finding of human resources and laboratory equipment necessary for practical activity and laboratory exercises are recommended so that the results achieved for example in software and simulation of hardware can reach a level appropriate to the intended objectives. The overall program is congruous with a training project of very competitive experts that also gives an advanced knowledge of modern technologies.The participation of the students in summer schools focused on computer science and information technologies is recommended.In addition participation at stage in national and international structures for example of advanced medical physics (protonterapy structures,) nuclear physics laboratory and advanced technology centers with the involvement of tutors of the same structures is recommend.

Conclusion: The proposed educational program of Department of Physics and Tecnology of al-Farabi Kazakh National University fulfills requirements for specialition " Instruments for nuclear and medical physics" of Department of Physics and Tecnology of al-Farabi Kazakh National University is heavely supported.

Expert
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Evaluation of the development of the undergraduate educational program "Instrument making" at al-Farabi Kazakh National University.

The program is based on courses of disciplines focused on the preparation of students specializing in the development and creation of new devices that can find application in various areas of basic and applied research. The program is designed to obtain basic knowledge of technological methods, approaches and developments that are used in nuclear physics and space experiments, in the nuclear industry, including nuclear medicine, and related fields. The program is designed for a four-year term of training bachelors.

The modern approach to educational activities suggests the need for basic knowledge, focused on a wide field of interdisciplinary research. The program in the specialty "Instrument making" is precisely aimed at training specialists who can be in demand in various fields of modern experimental physics. The balance of general and specialized disciplines is a guarantee that a student, having attended lectures courses of the program, will acquire basic knowledge and will be able to implement them in applied areas of modern physical research. The main direction of the program is focused on an integrated approach to the project and development, design, creation and work with the new generation of devices, which should ensure the acquisition of new knowledge in the coming years.

Obviously, a specialist who develops new devices for physical applications must have basic knowledge of various physical processes, which ultimately determine a particular technique and method for registration of observable phenomena. Therefore, the program includes courses in various areas of mathematics and general physics. Knowledge gained as a result of lectures on these disciplines is the foundation for the education of each university graduate.

As for specialized courses related to instruments and methods of experimental physics, their topics are focused on obtaining basic knowledge, which will allow to create new generation instruments. As a result of the work on the program, the following specialized courses were developed:

"Atomic Physics" - 3 credits. The main focus of the course development is on basic knowledge in the field of atomic theory, atomic spectroscopy and physics of atomic and ionic collisions.

"Nuclear Physics" - 4 credits. The main task of developing the course was the formation of basic knowledge of the characteristics of atomic nuclei, nuclear models, radioactive decay and nuclear reactions.

"Nuclear radiation detectors" - 4 credits. The main sections of the developed course make it possible to obtain basic knowledge of the main types of detectors of nuclear radiation, as well as the areas of their application in low and high energy physics. The main objective of the course is to formulate an approach to choosing the right type of detector for solving a particular physical problem.

"Interaction of radiation with matter" - 3 credits. The main goal of the course is aimed at forming ideas about the physics of the interaction of nuclear radiation -

electrons, protons, alpha particles, neutrons, gamma quanta, etc. with matter, about the main effects and phenomena accompanying the passage of radiation through matter and methods of experimental observation and description interaction processes.

"Instrumentation in advanced nuclear physics experiments" - 3 credits. The main task of developing the course was to form ideas about the basic principles of creating nuclear physics equipment and the functional requirements for instruments used in experiments at reactors and accelerators, in low-background underground laboratories, and also in space research.

"Automation of acquiring data from coordinate-sensitive and track detectors" - 3 credits. The main goal of the developed course is to obtain basic knowledge of modern approaches to automating physical experiments, the use of high-speed computers and software-controlled complexes, as well as the tasks and methods of automated retrieval and processing of information from coordinate and track detectors.

The developed program combines courses in the fundamentals of physics and mathematics with professionally oriented courses in various fields that are important for a specialist in the field of instrument making. A significant proportion of specialized courses developed on the basis of the priorities of modern experiments, including nuclear physics and space. The program is a new development in educational activities, which can be distinguished among similar programs of university courses.

Of course, for the implementation of the program requires highly qualified teachers. To give specialized courses, it seems necessary to invite leading scientists who are world leaders in the relevant field of study.

The developed program is fully consistent with the goals and objectives of the educational program in the specialty "Instrument making" for undergraduates. The program is very multifaceted and one can hope that its introduction into educational activity will allow to bring up in the near future a new generation of specialists who can adequately represent the achievements of the Republic of Kazakhstan on the world market of high technologies.

Deputy Director for Research of the Lebedev Physics Institute of Physics of the Russian Academy of Sciences, Doctor of Science (Physics and Mathematics), Professor

Ryabov V.A.

CONCLUSION

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on the educational program "Instrument making" developed in English for the specialty 5B071600 - "Instrument making" of the Kazakh National University named after Al-Farabi

Instrument making is a booming industry. This specialty has a wide application, starting with the development of modern electrical installations, designed both to solve fundamental scientific problems and to create devices in applied branches of science and technology, ending in the field of nuclear energy, defense technology, research, space and practical medicine.

The educational program "Instrument making" developed in English for the specialty 5B071600 - "Instrument making" of the Kazakh National University named after Al-Farabi is focused on the training of highly demanded, highly qualified specialists.

The planned training courses in the amount of 4 years of study are focused on the most advanced developments in the field of nuclear physics and nuclear medicine.

The content of the developed educational program in English "Instrument making" for the specialty 5B071600 - "Instrument making" is determined by the following professional activities of graduates: electronic and microprocessor systems of electrophysical installations, programming for complex electronic systems, Computer Aided Design systems, automated control of electrophysical systems, nuclear medicine, software and information technology in instrument making.

The main courses of training cover all relevant areas of nuclear physics and technology: physical and plasma electronics; corpuscular optics; physics of charged particle beams.

The specialty "Instrument making" is a training area that allows students to gain practical skills in the maintenance of electrical installations, their design, and gain experience in the practical application of the achievements of nuclear and atomic physics, both in industry and in scientific research. In this educational program students successfully owned the fundamental laws in the field of nuclear and particle physics, methods of theoretical estimates, calculations and design in nuclear physics and nuclear medicine. They study methods of computer and engineering graphics, theoretical foundations of

electronics and electrical engineering, fundamental laws in the field of particle physics and the atomic nucleus.

Students who have successfully passed this educational program will be highly in demand in various enterprises specializing in such high-tech areas as the nuclear and defense industries, nuclear medicine, applied and basic scientific research.

The training of specialists in instrument making is an urgent task for the economy of the Republic of Kazakhstan, given the presence of a developed Nuclear industry. Kazakhstan has a leading position in the world in terms of uranium reserves and production. The republic plans to build a nuclear power plant in the future; nuclear technologies are actively developing based on the peaceful use of atomic energy.

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Подпись заверяю
Зам. директора по
персоналу
Л.В. Василькина

REPORT of S. B. Shaulov (Moscow Institute of Physics and Technology, Russia) on participation in the development of bachelor educational Program "INSTRUMENT MAKING" KazNU Al Farabi.

In the process of development of the Program "INSTRUMENT MAKING" of KazNU. Al Farabi, held meetings and discussions with the department and faculty managements, doctoral students and students.

The program is designed for four years of study by bachelor and represents a combination of General and specialized courses. It seems justified to include in the program a course of General physics in the preparation of specialists in instrument engineering. This course broadens the mind and is the basis for the design, construction and operation of devices of different types.

You should allocate a few more courses of the General orientation included in the program. These are computer science, computer technology, probability theory, mathematical statistics, methods of processing experimental data. Not all University programs include these courses. Often the departments of mathematics and physics do not consider them their own. At the same time, without deep knowledge of these disciplines, it is impossible to engage in practical activities in the modern world. Including them in the program of the Treasury is a big plus, but also a problem. The problem is related to the search and selection of qualified teachers specializing in these areas.

You can be sure that the range of courses included in the program provides universal training of students. This makes it quite easy to change their specialization in accordance with the real requirements of modern industry and economy. Universality is one of the strengths of the Program. This is what distinguishes it among similar programs of other Universities. In the rapidly changing modern world, the mobility of the learning system is one of the main qualities of education. However, the universality of the program imposes increased requirements on the composition of the teaching staff of the University. Closer cooperation with other Universities could help to solve this problem.

Along with the universality of basic training, the program takes into account the need to specialize students to work in areas in demand by the industry of Kazakhstan. First of all, the Program is aimed at training specialists in two main areas:

- Nuclear industry.

- Nuclear medicine.

There is no doubt that such specialization is in demand all over the world, these areas are rapidly developing and the probability of employment of specialists in these areas is quite high. However, the issue of employment of students in the first place should be considered in the context of the development of the nuclear industry and medicine in Kazakhstan.

My contribution is mainly related to the development of the following courses:

1. General physics.
2. Physics of atomic nucleus and elementary particles.
3. Particle detectors.
4. Nuclear radiation in a variety of environments.
5. Simulation of nuclear-physical installations.

The development of these courses was conducted in close cooperation with the staff of ITEP KazNU. Among the extensive information on General physics in the first place were selected courses required in the development of modern devices , as well as specialization in nuclear physics.

When creating programs of specialized courses, the main attention was paid to two directions:
- fundamental training of students in the field of nuclear physics;
- the basics of practical work with nuclear-physical facilities and their design;

General description of Program "INSTRUMENT MAKING".
Year of study: 2019
Duration of training: 4 years
Form of study: full-time
Level of education (qualification): bachelor
Description of the educational program is attached.

CONCLUSION.

Direction "INSTRUMENT MAKING" provides training of specialists capable of developing and designing devices and systems for various purposes: information and measurement, laser, acoustic and others.

The program is fully consistent with the objectives of the educational program in the specialty "INSTRUMENT MAKING".

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Sergey Shaulov

ЗАВЕРЯЮ
УЧЕНЫЙ СЕКРЕТАРЬ
Ю.И.С

Review

Of the Educational Program in English

By Specialty 5B071600 - Instrument Making

This review is written in favor of the educational program "Instrument making" developed under the auspice of Al-Farabi Kazakh national University, which is to be taught in English for bachelor students.

It has to be immediately noted that instrument making and design is a very active area of development in the current world. This is not an accidental conclusion since general practice of human activities inevitably implies that quite specific problems are to be met in various fields. It is especially true for the field of nuclear physics and related applications in medicine, since various tools, ranging from simple radioactive materials to rather sophisticated accelerators, have been recently put into operation for the purpose of both diagnostics and treatment of various deceases. It is thus obvious that very advanced apparatus are now available on the market and to operate them in an appropriate way qualified personnel is needed. I realize that another step forward is creation of new types of instruments that will require quite versatile row of competences.

As I see it now any professional in this specialty should demonstrate quite considerable skills in the professional area as well as comply with high standards of ethics. That is why I strongly support the General Education module in the program. Another advantage comes from the very well structured and professionally oriented module of Basic disciplines because a student must understands the main principles underlying the instrument operation. I also appreciate the idea of using individual tracks for students since one cannot support high level of expertise in the whole range of instrument making and design. Moreover, such individual tracks can be very convenient for stakeholders and potential employers assuring close relations with the industry and promoting successful employment.

In this regards, however I would like to have a schematic picture of modules that students should take in order to end their period of study with particular field of activity and job placement. This will significantly facilitate further activities in implementation of this education program.

In conclusion I want to stress that specialists in the field of instrument making and design are in high demand throughout the world and Kazakhstan is not an exception here. That the program is to be taught in English is certainly a plus since the corresponding areas are very rapidly developing and a flow of literature is coming from internationally recognized sources published in English language.

Ass. Professor of Almaty University

of Power Engineering and Telecommunications K. Zhunussov

Персоналды басқару жөніндегі бөлім

Отдел по управлению персоналом

Қолтаңбаны растаймын

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EXPERT EVALUATION

of the educational program in English "Instruments making" developed for the specialty 5B071600 - Instrument making of the Faculty of Physics and Technology of al-Farabi Kazakh National University

The purpose of the submitted educational program in English "Instruments making" is to provide basic academic knowledge, skills and both cultural and professional competencies for the bachelor students of specialty 5B071600 - Instrument making.

Program compose from Compulsory Component (46 credits), Elective Course (57 credits) and individual educational trajectories (27 credits) and also cover the practice part. Specialists not only from al-Farabi Kazakh National University, but also well-known specialists from research institutes of Japan, Finland, Russia, Germany and Italy took part in the development of this program. All this indicates that the program is developed according to international standards and experience.

The relevance of the developed program does not cause doubts, because science is constantly evolving, studying and mastering new processes are taking place, microprocessor technology and information technologies are developing. Therefore, it is necessary to educate and train specialists who will conduct research and development in the field of creating modern instruments and systems for obtaining, recording and processing information about the environment, biological and technical objects, as well as repair and operation of instruments.

This educational program will prepare specialists with a basic and intermediate level of knowledge in the field of instrumentation for nuclear physics and medicine. These two areas are high-tech and relevant areas of applied science.

It is also important to note that the program contains computer simulation, basics of automation, computer technologies in instrument making, basics of python programming language and etc. without these courses it is hard to imagine modern instrument making. The institutional practice at industrial companies will allow better consolidate theoretical courses.

In conclusion, I would like to say that the courses cover all the necessary topics for the education of specialists in the field of instrumentation making for nuclear physics and medicine.

Based on the foregoing, I recommend this educational program for further implementation in order to education of undergraduate students in the specialty 5B071600 - Instrument making.

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Witness to the above signature
Scientific Secretary
Cand. of Phys. and Math. Sciences, assoc. prof. — Gulzhan Koztayeva

Review on the educational program in English Instrument Making for Specialty 5B071600 - Instrument making

Each educational program review its role and scope by considering the program's goals and measurable objectives. These goals and objectives will be evaluate to determine their relationship to the university purpose and the institutional mission and goals. In this review, in brief statements, has been set out a reflecting this analysis.

Consideration of the centrality of individual courses comprising the program includes a review of the courses' description, audience, and objectives, and their relationships to the mission and goals of the university.

Quality of Programs, including faculty credentials – a description of faculty who teach in the program or in the specific courses constituting the program is included. This mini vita includes their name, a short description of their degrees and related training, and a brief summary of their teaching and related experience. Next is quality of students – evaluation of quality of students based on graduation GPA average for the four years, with each year being considered separately. Placement test scores also considered for each of the four years for which the average percentile per year, mean, and standard deviation is calculated. Further, the adequacy of the curriculum evaluated by the follow-up questionnaires and with advisory committee input.

This review based on the consideration of outcome proficiencies and their relationship to program goals. Important item is adequacy of library holdings – program directors discussed this with the Library Director and a bibliography of library holdings in each program, which developed in educational program.

One of basic circumstance is adequacy of facilities and equipment – a statement describing the adequacy of the facilities and the equipment to support the program. This statement also includes existing equipment and plans for growth or future equipment purchases.

Last item is adequacy of support staff – a statement indicating the type of support staff and services available to the program included. The efficacy of these services analyzed and included.

My recommendations for the program is include classes for modern electronics for precise measurement, for curricular changes in the program to allow it to better meet student and employer needs, now and in the future.

I recommend this program for using in Kazakhstan.

Associate professor,
vice president of limited partnership
"GRANIT", Almaty, Kazakhstan

Vasiliev Ivan

5B071600 - Instrument making Specialty educational program in English

REVIEW

Engineering applies pure natural scientific theories, mathematical methods and empirical evidence to design, create, and analyze technological solutions cognizant of safety, human factors, physical laws, regulations, practicality and cost. In the contemporary era, importance of engineering is obviously, and we need in sustainable development of every actual fields of it.

This educational program stay in interdisciplinary area, between electronics, nuclear physics and medicine. Goals and objectives of program correspond to the State program of development in the educational sphere.

In this review, I made a brief statement for most important items of the program, analyzing all parts of it.

Program has all necessary background for give a high quality knowledge and skills to the students. Basic disciplines distributed by optimal way for generalization of the initial starting position for learning major and elective disciplines. Consideration individual trajectories show that both two component is actual and has very modern disciplines. Program includes a description of all disciplines. Courses' description has all necessary information and their structure is optimal for teaching and preparing syllabuses on their base. Description of self-work and training and a brief summary of their teaching and related experience is clear. Graduation of GPA average considered separately for each disciplines. One of the basic circumstances is existence of all facilities and equipment to support the program.

Quality of the Program is very good. Outcome proficiencies and their relationship to program goals described very well. Important item is that developers discuss with the employers and other interested sides in the period of preparation of educational program.

I recommend to use 5B071600 - Instrument making educational program for study and training in Kazakhstan universities good specialists in corresponding fields and I believe, that they will be competitive.

Medical physicist, Joint stock company «KAZAKH INSTITUTE OF ONCOLOGY AND RADIOLOGY (KAZIOR)»

Tulbayeva Nurgul

Evaluation
of the Bachelor Educational Program
"Instrument Making"
Specialty "5B071600 - Instrument making"

The main goal of the proposed educational program is to prepare highly qualified specialists in the field of instruments for nuclear physics and medicine with profound knowledge and competences necessary for employment in industries and institutions with scientific, engineering and medical backgrounds. This is of extremely high importance for successive development of the peaceful use of atomic energy. The importance of the R&D in the field of the peaceful use of atomic energy is reflected in the Manifesto "The World. The 21st century" by the President of the Republic of Kazakhstan Nursultan Nazarbayev.

One of the strong sides of the program is that the program is designed in a way that the students gain a very strong background in basic physics and mathematics in first two years of education, prior to majors, which makes the program consequential, logical, well balanced and complete.

The other strong side is that it has two well defined directions – experimental nuclear physics and nuclear medicine, two fields in which the Institute of Nuclear Physics is the leading organization in the Republic of Kazakhstan. The Institute needs qualified specialists in these fields. In this connection I would also like to outline the very important feature of this program that is a huge attention is paid to develop the students' programing skills in C++ and Python as well as with the most modern software tools for simulation and data analysis, such as ROOT, GEANT4 etc. which I find of high importance for R&D.

The cultural and professional competencies of the graduates will undoubtedly make them capable of the declared professional activities that are: Researcher, Specialist and Laboratory Assistant in Research Institutions; Nuclear engineer; Consultant at R&D; Medical Device Engineer.

In conclusion I strongly support the Educational Program "Instrument Making" for specialty "5B071600 - Instrument making" to Higher Educational Institutions of the Republic of Kazakhstan

Head of the Laboratory of Low Energy
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Dr. of Phys. and Math. Sciences, professor Nassurlla Burtebayev

Witness to the above signature
Scientific Secretary
Cand.of Phys. and Math. Sciences, assoc. prof Ulzhan Koztayeva

Evaluation of the

Bachelor Educational Program
Specialty 5B071600 - **Instrument making**

The aim of the program is preparing highly qualified specialists in the field of instruments for nuclear physics and medicine with profound knowledge and competences necessary for employment in industries and institutions with scientific, engineering and medical backgrounds.

Important directions in the programs: activities in the field of engineering surveys, technical testing, research and development in the natural sciences and engineering, repair and maintenance of varies equipment, manufacture of instruments for physical research.

The main advantage of this program is professional competence of graduates. They are able to calculate, create and construct in accordance with specifications of systems, tools, details and components on the level of schemes and elements using standard means of automating projects; carry out design calculations and preliminary feasibility studies of projects.

Graduates are able to use modern software for the preparation of design and technological documentation, process and present the experimental research results, have skills of rules and methods of installations, adjustment and adjustment of the nodes of devices and systems, including those related to the inclusion of a human operator in the control loop.

In addition, the graduate knows the principles of safety, is ready to assess nuclear and radiation safety, environmental impact assessment, monitor compliance with environmental safety, safety standards and rules of industrial sanitation, fire, radiation and nuclear safety, labor standards.

It can also be stated that the topics under consideration provide the development of the most important for the instrument-specific competencies, such as: foreign language skills, scientific communication and management, the ability to enter into new areas, literature search, assessment and modeling skills, both oral and written communication skills of technical material.

Conclusion: it is necessary to recommend the **Instrument-making** program for acquaintance and introduction in educational institutions of the Republic of Kazakhstan

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Sadykov T. Kh.

КЕҢСЕ
КАНЦЕЛЯРИЯ

ҚОЛ ТАҢБАСЫ КУӘЛАНДЫРАМЫН
/ПОДПИСЬ ЗАВЕРЯЮ
Ғылыми хатшы/Ученый секретарь
«Физика-техникалық институты» ЖШС
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EDUCATIONAL PROGRAM

INSTRUMENT MAKING

Specialty 5B071600 - Instrument making

Sincethe first discovery of the atomic nucleus by Rutherford in the early 20th century the development of nuclear physics has been intimately tied to the development of new detection techniques, accelerators and to theoretical and simulation frameworks. A large number of these nuclear physics methods have found, and will find, applications in daily life, as energy, nuclear waste processing and transmutation, climate change containment, life sciences, medicine like cancer therapy, environment, space, security and monitoring, materials science, cultural heritage, archaeology and etc.

"EDUCATIONAL PROGRAM INSTRUMENT MAKING" will provide academic knowledge and skills for production and development of specialized instruments for nuclear physics and medicine field which could includes:

-equipment and instruments for hadron therapy: hadron radiotherapy facilities, accelerators, beam delivery, dosimetry, moving targets, radiology, modelling, treatment planning, Boron neutron capture and etc.

-equipment for medical imaging: PET, SPECT, CT, Xray equipment (nuclear imagining, molecular imaging, detectors, reconstructions and simulations, etc.)

-equipment forradioisotope production: cyclotrons, generators, hotcells and etc Collaboration of instruments for nuclear physics and medicine is the great contribution to development of Kazakhstan.

By applying knowledge on engineering, in experimental and theoretical research in the fields of electronics, devices developing in medicine, instruments and equipment for nuclear medicine undergraduates will make big contribution for saving life's of people.

New generations of specialist who will graduate "EDUCATIONAL PROGRAM" are thehighly qualified specialists in the field of instruments for nuclear physics and medicine with profound knowledge and competences necessary for employment in industries and institutions with scientific, engineering and medical backgrounds. This is new generation of specialist who easily is oriented in methods, medical innovations, values and legal aspects.

Cand. Phys. and Math. Sciences Valeriy Zhukov

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ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
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АССОЦИАЦИЯ НАУЧНЫХ И
ТЕХНОЛОГИЧЕСКИХ ОРГАНИЗАЦИЙ
РЕСПУБЛИКИ КАЗАХСТАН

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Review

of the Educational Program in English

"Instrument Making"

Instrument making is one of the main part of modern engineering and, accordingly, preparation of the technicians and engineers on this specialty for Kazakhstan industry is very important part of the State politics. Developing the educational program in English is also a very good idea, because the main part of leading technologies provides detailed descriptions and new actual books in this language.

The considered program consists of Passport of the educational program, List of competences to be acquired, Table of correlation of the expected learning outcomes of the program learning with evaluation tools in the formation of program competences, Body of the educational program, Learning units of subjects and Catalog of disciplines. All these parts are necessary components of a modern educational program. Disciplines of the General compulsory and elective components differ by goals from Basic compulsory and elective components, Major compulsory and elective components and Individual trajectory components, as well as necessary training credits. Main part of the Basic and Major components disciplines has laboratory classes, which are important for engineering specialty, as well as internship in industry. I find that splitting the program into two individual trajectories is optimal, covering well-known branches of Theoretical and Nuclear physics department of Al-Farabi KazNU, where high-level research and development in the fields of nuclear and medical instruments is conducted.

Accordance of the content of professional disciplines to modern situation in the corresponding sphere and compliance with the technical and safety requirements during education process are clearly declared in the document, and give me assurance on effectiveness of the program implementation.

It is also recommended to reduce the number of social disciplines in favor of professional ones.

I recommend this program as actual, well-made and contemporary for preparation engineers in the sphere of instrument making in Kazakhstan.

Executive Director
Associations of scientific and
technological organizations
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