

MINISTRY OF EDUCATION AND SCIENCE
REPUBLIC OF KAZAKHSTAN

al-Farabi Kazakh National University

Faculty of Physics and Technology

Solid State Physics and Nonlinear Physics Department

EDUCATIONAL PROGRAM
specialty 5B061100 – Physics and Astronomy

Almaty, 2018

LIST OF AUTHORS-DEVELOPERS EDUCATIONAL PROGRAM

Foreign universities and organizations - partners:

- 1) University of North Carolina at Greensboro, North Carolina, United States
Professor of Dept. Physics & Astronomy – Dr. Miroshnichenko Anatoly.
- 2) National Autonomous University of Mexico, Mexico City, Mexico
(Universidad Nacional Autónoma de México) – Dr. Zharikov Sergey.
- 3) Xinjiang Astronomical Observatory, CAS, Urumqi, Xinjiang, China,
Deputy Director of XAO, CAS – Dr. Jarken Esimbek.
- 4) Max Planck Institute for Astronomy, Heidelberg Germany – Dr. Olga V. Zakhzhay.
- 5) National Autonomous University of Mexico, Mexico City, Mexico
(Universidad Nacional Autónoma de México) – Dr. Quevedo Hernando.

al-Farabi Kazakh National University:

- 1) The Head of the Department (Phd) of Solid State Physics and Nonlinear Physics Ibraimov MK,
- 2) Professor (Doctor of Physics and Mathematics) of the Department of Solid State Physics and Nonlinear Physics Zhanabaev Z.ZH.
- 3) Candidate of Physical and Mathematical Sciences, Senior Lecturer of the Department of Solid State Physics and Nonlinear Physics Iztleuov NT
- 4) Candidate of Physical and Mathematical Sciences, Senior Lecturer of the Department of Solid State Physics and Nonlinear Physics Naurzbaeva A.ZH.,
- 5) PhD, senior lecturer of the Department of Solid State Physics and Nonlinear Physics Khokhlov S.A
- 6) A teacher (doctoral student) of the Department of Solid State Physics and Nonlinear Physics Kalambay M.T
- 7) Candidate of Physical and Mathematical Sciences, Acting Professor, Department of Solid State Physics and Nonlinear Physics Kuratov K.S
- 8) PhD, teacher, Department of Solid State Physics and Nonlinear Agishev A.T.,
- 9) Candidate of Physical and Mathematical Sciences, Senior Lecturer of the Department of Solid State Physics and Nonlinear Physics Mailybaev A.T.
- 10) Director of the Department of Academic Affairs - Mukhitdinova T.M

Reviewers

- 1) DTOO “FAI (Fesenkova Astrophysical Institute)” - Doctor of physical and mathematical sciences, Professor Chechin L.M.
- 2) DTOO Institute of the Ionosphere, Doctor of physical and mathematical sciences, Professor Somsikov V.M.

Domestic educational institutions:

1) Satpayev University - Doctor of Physics and Mathematics, Professor A.A. Bekov

Representatives of foreign employers:

1) Max Planck Institute for Astronomy, Heidelberg Germany – Coordinator of IMPRS HD, prof. apl. Dr. rer. nat. Christian Fendt

Employer Representatives:

1) JSC National Centre for Space Research and Technology, Deputy Director for Research, Candidate of Physical and Mathematical Sciences - Valiullin R.R

2) SEE on REU “Research Instit of Experimental and Theoretical Physics” - Scientific Secretary, Candidate of Physical and Mathematical Sciences - Imanbaeva A.K.

3) President of JSC "National Center for Space Research and Technology" Candidate of Physical and Mathematical Sciences - Omarov Ch.T

4) Director of a municipal government institution "Gymnasium №34" - Z.T. Beysenbayeva

5) Nazarbayev Intellectual School JSC NIS KhBN, Almaty, teacher of Physics, PhD - Sandybaev E

6) Doctor of Technical Sciences. Member of NNS from NPP "Atameken" - Taybasarov Zh.K.

1. Application area

The educational program on the specialty «Physics and astronomy» was developed on the basis of the Model Curriculum for the specialty 5B061100 – Physics and astronomy (from August 23, 2012 with changes in May 13, 2016) in accordance with international documents in the field of higher education, recommendations of ECTS Users' Guide (Guide to Using ECTS), “Tuning Educational Structures in Europe”, and setting educational content requirements through study, the volume of academic load and the 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 Republic of Kazakhstan “On Education” (№ 319-III dated July 27, 2007 in the wording of the Law of the Kazakhstan Republic dated 24.10.11 № 487-IV, with changes and additions from 04.07.2018);

2. The state compulsory standard of higher education, approved by the Government of the Republic of Kazakhstan from August 23, 2012 №1080, with changes from May 13, 2016 № 292;

3. The model curriculum for the specialty 5B061100 – Physics and astronomy, approved by order of the Minister of Education and Science of the Republic of Kazakhstan dated July 5, 2016 № 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. National Qualifications Framework approved by the Protocol of the Republican tripartite commission on social partnership and regulation of social and labor relations on March 16, 2016;

6. Typical educational program 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.

3. Basic 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. Fundamentals

4.1 Educational activities at the university are carried out according to the credit technology of education on the basis of a student-oriented approach, in which learning outcomes and competences play a major role and become the main result of the educational process for the student.

4.2 The educational program for the specialty «Physics and Astronomy» was developed in accordance with national standard of education of RK, the National Qualifications Framework and is consistent with the Dublin descriptors and the European Qualifications Framework. The educational program is focused on learning outcomes.

4.3 Foreign and domestic specialists and employers are involved in the process of developing the educational program by the specialty "5B061100 - Physics and Astronomy".

4.4 Priority areas for the development of the educational program in the specialty "5B061100 - Physics and astronomy" are:

- programs in the framework of the President's Messages, including those voiced in the text of the message "The Third Modernization of Kazakhstan: Global Competitiveness", "Digital Kazakhstan";
- interdisciplinary programs;
- programs in English learning;
- joint educational programs with foreign partner universities;
- professional programs commissioned by enterprises-employers;
- programs using distance learning technologies, including programs of additional education.

4.5 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.

4.6 The educational program is designed to provide high quality professional education in materials science and engineering in accordance with the highest academic standards in the global education.

The program has theoretical and practical components. Terms of mastering: 4 academic year. Duration of one academic year - 2 semesters for 15 weeks. Forms of education: full-time. During the period of study, the student learns 155 credits, of which theoretical training - 130 credits, professional practice - 14 credits, physical education - 8 credits and final attestation - 3 credits.

Awarded degree with full development of the educational program - Bachelor of Natural Science in the specialty "5B061100 - Physics and Astronomy."

5. Code and title of the specialty

The code of specialty 5B061100 - Physics and Astronomy; in accordance with the Classifier of specialties of higher and postgraduate education of the Republic of Kazakhstan, this educational program belongs to the Natural Sciences section.

In the National Classifier of the Republic of Kazakhstan (NC RK 01-2017 Classification of Occupations), bachelors have the code 2111 and classified as professionals in the field of science and technology.

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

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

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

4 Science	44 Physical sciences Astronomy and cosmology , physics, other related subjects, chemistry, other related subjects, geology, geophysics, mineralogy, physical anthropology, physical geography and other earth sciences, meteorology and other atmospheric sciences, including climate research, oceanography, volcanology, paleoecology
-----------	---

7. Objectives of the educational program

The educational program is focused on the training of highly qualified specialists in the field of physics and astronomy, with certain knowledge and competencies demanded in the labor market.

Objectives of the educational program are:

- formation of a national model of continuous 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 5B061100 - Physics and Astronomy;
- training highly qualified specialists with abilities for self-improvement and self-development, possessing solid knowledge in the field of physics, astronomy, astrophysics and cosmophysics: those who know the most well-known basic theories and models of astronomical and cosmophysical phenomena and processes, the possibility of their practical application; knowledgeable and able to apply the basic experimental, theoretical and numerical methods for studying astronomical phenomena and processes, physical properties and characteristics of space objects and radiation; capable of processing the results of scientific research and their analysis using new computer technologies;
- obtaining broad fundamental knowledge, competencies and skills necessary to work in research institutes, laboratories, design and design bureaus and firms, public and private institutions of the relevant profile;
- formation of graduates' competitiveness in the job 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 to continue education in the magistracy and training in doctoral PhD.

8. Sphere of professional activity

Sphere of professional activity of the bachelor of specialty 5B061100 - Physics and Astronomy is:

- area of experimental, theoretical and applied astronomy and cosmophysics, as well as the field of related natural and technical sciences;
- academic and research institutes associated with observational and theoretical astronomy;
- branches of ministry of defense and aerospace industry of the Republic of Kazakhstan.

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

- 94.12.0 Activities of professional organizations;
- 72.19.0 Other research and development in the natural sciences and engineering;
- 74.90.9 Other professional, scientific and technical activities not included in other categories;
- 62090 Other activities in the field of information technology and computer systems;

- 63.12.0 Web portals;
- 26.51.4 Production of optical and optical-mechanical devices and equipment;
- 26.70.1 Optical Instrument Manufacturing;
- 30.30.2 Production of spacecraft.

9. Directions of professional activity

Graduates in the specialty 5B061100 - Physics and Astronomy can perform the following professional activities:

research

- study of astronomical objects and related physical processes;
- analysis of physical processes and phenomena in astronomical objects, the establishment of empirical dependencies and patterns;
- formulation and solution of actual problems of physics and astronomy, including quantitative estimates of the parameters of astronomical objects and the interstellar medium;

organizational and management

- organizing and conducting special astronomical observations;
- organization of a rational astronomical network of observations;
- collection and storage in databases of necessary information about astronomical objects;

engineering design

- monitoring and maintenance of devices and instruments of astronomical stations;
- development of software and hardware systems for professional activity using modern information and communication technologies.

10. Competence of the specialist

Material science graduate should have general cultural (GC) and professional (PC) competencies, including the ability to:

Competence Code	Competency description
GC-1	formulate the main stages of the modern history of progressive development of the statehood of Kazakhstan in context of the world and Eurasian historical process;
GC-2	fluently 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;

GC-3	demonstrate the 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;
GC-4	represent social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;
GC-5	Understand and apply knowledge of the basic physical laws in nature, and their connection with the observed phenomena and processes; use inductive and deductive approaches to cognition;
GC-6	search and use of information necessary for the effective performance of professional tasks; set a goal and choose ways to achieve it;
GC-7	work in a group and a team, communicate effectively with colleagues, supervisors; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions;
GC-8	demonstrate critical thinking while working with new information;
PC-1	Analyze and apply the physical laws of mechanics, molecular physics, electromagnetism, optics, atomic physics, nuclear physics, theoretical physics, fundamentals of radio physics and electronics for measuring and interpreting experimental data
PC-2	Apply physical laws to study of the structure, origin and evolution of astronomical objects and the Universe as a whole;
PC-3	Determine coordinates of celestial bodies and date of astronomical occasions by calculations and using of the star wheel;
PC-4	Collect and analyze of observational materials (astronomical catalogs and databases) for the studying of astronomical objects and the Universe as a whole;
PC-5	Make special calculations of astronomical values and simulating physical processes occurring in outer space;
PC-6	Use methods of information stream processing for astronomical data, use a computer systems of collecting, processing and storing of observational material for the study of astronomical objects and the Universe as a whole;
PC-7	Apply modern mathematical methods for analyzing of astrophysical signals and use modern digital space and ground based technologies for receiving and processing data;
PC-8	Organize a scientific research and conduct astronomical observations by using modern telescopes and receivers of cosmic electromagnetic radiation and observation methods (spectral, photometric, etc.);
PC-9	Work with a specialized scientific source bases, use modern computing equipment and software for conducting a scientific research work;

PC-10	Evaluate the results of scientific research in the field of physics and astronomy, prepare of conclusions and proposals for their practical application;
PC-11	Present information, ideas, problems, solutions and results of scientific research in the field of physics and astronomy to specialists and non-specialists;
PC-12	Acquire and use new knowledge and skills; participate in scientific discussions, write scientific papers.

11. Learning outcomes oriented to Dublin descriptors

Upon completion of this educational program it is expected that students will be able to:

Cognitive competencies:

A1. understand the physical picture of the world, the basic physical processes responsible for the nature and observable features of space objects and phenomena; explain the basic laws of the functioning and development of nature and society, to be able to adequately navigate in various socio-economic, political and emergency situations; 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 the established state - the Republic of Kazakhstan;

A2. describe the physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole; search for information necessary for the effective performance of professional tasks;

A3. explain the main stages of the evolution of stars and other objects of the galaxy.

Functional competencies:

B1. analyze the characteristics, physical and chemical properties, laws of formation, development, structure and movement of the studied celestial bodies and their systems;

B2. explain the physical principles of operation of modern receivers of cosmic electromagnetic radiation, the construction of telescopes used in all ranges of the electromagnetic spectrum;

B3. explain the principles of processing information flows of data, use computer systems for collecting, processing astrophysical data;

B4. apply basic electronic equipment and physical instruments to measure astrophysical quantities;

B5. demonstrate skills in working with hardware and software for providing astronomical observations, basic physical processes, and features of the interaction of radiation from astronomical objects with the environment.

System competencies:

C1. use the mathematical apparatus and formalisms in modern theoretical astrophysics, the criteria for choosing methods for solving problems both in analytical form and using computer technologies (modern computers and corresponding software products);

C2. formulate algorithms for modeling the processes occurring in outer space;
C3. compare the results of processing observational data with known ideas and draw conclusions.

Social (communicative) competence:

D1. 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, analyse and synthesis of information, as well as present the own point of view.

12. The ratio of the expected learning outcomes of training methods and assessment in the formation of competence

The formation of competence through learning outcomes will be achieved by proposed technology and teaching methods:

Application of IT technologies; presentations; conversation; disputes; educational, imitation games; training discussions; work with educational and scientific literature.

And control and evaluation tools:

Survey, test, colloquium, midterm control, MidtermExam, consultations, exam, tests.

Code and Competency Description	Expected results	Module with an indication of credits numbers
GC-1 Formulate the main stages of modern history of the progressive development of the statehood of Kazakhstan in the context of the world and Eurasian historical process;	- explain the basic laws of the functioning and development of nature and society; - to adequately navigate in various socio-economic, political and emergency situations, political and emergency situations; - reproduce the historical foundations and periods of formation of independent Kazakhstan statehood in the context of the World and Eurasian historical process;	– Social and Humanitarian Module – 6 cr.; – Module of socio-political knowledge – 4 cr.; – Module of cultural heritage and interpersonal communication – 4 cr.;
GC-2 Interpret and creatively use scientific, historical and philosophical knowledge to summarize the success factors of the Kazakhstan development model on the	– distinguish the role of history as a world view and the basis of scientific knowledge; essence and interrelations of general scientific pictures of the world; – objectively and comprehensively interpret the advantages, features and significance of the Kazakhstan development model;	– Social and Humanitarian Module – 6 cr.; – Module of socio-political knowledge – 4 cr.; – Module of cultural heritage and interpersonal communication – 4 cr.;

way to an established state - the Republic of Kazakhstan;	– to analyze and evaluate socially significant phenomena, events, processes; to understand and analyze socially significant problems and processes, to apply the basic principles and methods of social sciences in solving social and professional problems; – build the foundations of sociohumanitarian knowledge, understanding of the driving forces and laws of the historical and socio-cultural process, the socio-political organization of society;	
GC-3 Demonstrate the 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;	- 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; to the perception, analysis, synthesis of information, setting goals and choosing ways to achieve it; – develop programs for solving conflict situations in society, including in professional society; – carry out research project activities in various areas of communication, generate socially valuable knowledge, present it;	– Instrument Module - 15 cr.; – Module of cultural heritage and interpersonal communication - 4 cr.; – Module "Professional Language" - 4 cr.;
GC-4 Represent social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;	- analyze the diversity of cultures and civilizations, evaluate the role of civilizations in their interaction. - summarize the results of mental, historical-typological, interpersonal analysis to determine the place of professional activity in the cultural and historical paradigm	– Social and Humanitarian Module - 6 cr.; – Instrument Module - 15 cr.; – Module of socio - political knowledge – 4 cr.; – Module of cultural heritage and interpersonal communication - 4 cr.;

	– to assess and possess the skills of respect for the cultural heritage and man; information on the driving forces of the psychological process.	
GC-5 Understand and apply knowledge of the basic physical laws in nature, and their connection with the observed phenomena and processes; use inductive and deductive approaches to cognition.	– interpret basic mechanical phenomena; basic concepts and physical quantities from the course of mechanics; the basic principles and laws of mechanics, their logical content, mathematical expression and area of applicability; - use specialized knowledge in the field of physics for mastering specialized physical disciplines; - interpret basic mathematical concepts included in this program, their interrelation, interdependence and mutual influence not only among themselves, but also with other mathematical disciplines; - explain, find, formulate and solve actual and significant problems of fundamental and applied mathematics; - solve the problem, apply classical mathematical models to the task, justify the correctness of the mathematical model; - correctly apply the basic methods of mathematical analysis to the solution of various mathematical problems of other disciplines;	– Module "General Physics 1 and higher mathematics" - 10 cr.; – Module "Innovative teaching methods and digital technologies" - 6 cr.; – STEM - Module - 7 cr.; – Module "General Physics 2" - 9 cr.; – Module "General Physics 3" - 8 cr.; – Module "Workshop on general physics" - 7 cr.; – Module "Theoretical Physics" - 6 cr.;
GC-6 Search and use of information necessary for the effective performance of	- interpret and independently create new mathematical models in the natural sciences and explore them;	– Instrument Module – 15 cr.; – Module "General Physics 1 and higher mathematics" - 10 cr.; – Module "Professional Language" - 4 cr.;

professional tasks; set a goal and choose ways to achieve it;	- propose methods of mathematical and algorithmic modeling in the analysis of problems from other disciplines; - argue the own vision of the applied aspect in rigorous mathematical formulations; - explain the paradigms of the composition, syntax and semantics of languages, basic models, approaches and techniques in the study of languages; - understand the basic principles and logic of programming programming languages, basic functions and procedures - build efficient algorithms and implement them in various programming languages; conduct lexical analysis, syntax analysis, effective software implementation;	– STEM - Module - 7 cr .; – Module "Physics of Stars" - 8 cr .; – Module "Theoretical Physics" - 6 cr .;
GC-7 Work in a group and a team, communicate effectively with colleagues, supervisors; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions	- communicate on the content and problems of the specialty both with colleagues at work and with representatives of the general public, including from other countries in a foreign language; - to demonstrate the understanding of the principles, laws and categories of philosophy in the process of solving professional scientific problems; - to substantiate the skills of analytical and axiological analysis in the study of complex historical processes, phenomena and historical personalities of modern Kazakhstan.	– Social and Humanitarian Module– 6 cr.; – Instrument Module – 15 cr.; – Module of socio-political knowledge – 4 cr.; – Module of cultural heritage and interpersonal communication - 4 cr.; – Module "General Physics 1 and higher mathematics" – 10 cr.; – Module "Innovative teaching methods and digital technologies" – 6 cr.; – Module "Professional Language" - 4 cr.;

	- to apply computer methods of collecting, storing and processing information used in the field of professional activity; - recommend standard test methods; - explain the reasons and solve the tasks with the use of databases and literature.	– Module "Physics of Stars" - 8 cr.; – Module "General Physics 2" - 9 cr.; – Module "General Physics 3 " - 8 cr.; – Module "Workshop on general physics" - 7 cr.; – Module "Theoretical Physics" - 6 cr. ; – Module "General Astronomy" - 5 cr. ; – Module "Cosmology" - 9 cr.; – Module "Star Astronomy" - 9 cr.; – Module "Physics of Planetary Systems" - 9 cr.; – Module "Observational astronomy" - 9 cr.; – Module "Kinematics and physics of celestial bodies" - 9 cr.; – Module "Digital technology and data processing in astronomy" - 9 cr.; – Professional practice module - 12 cr.
GC-8 Demonstrate critical thinking while working with new information	- to assess the skills of creative, critical thinking and the use of tools of critical thinking to the analysis of scientific, cultural, social and political phenomena and processes. - propose methods of mathematical and algorithmic modeling in the analysis of problems from other disciplines;	– Module "General Physics 1 and higher mathematics" - 10 cr.; – Innovative teaching methods and digital technologies – 6 cr.; – Module "Physics of Stars" - 8 cr.; – Module "General Physics 2" - 9 cr.; – Module "General Physics 3 and Pedagogy" - 8 cr.;

	- have the skills to solve problems in order to mathematically correctly put a specific simple task of practice, choose a method for its solution and solve it; - correctly correlate the content of specific tasks with the general laws of physics, apply the laws of mechanics to solve physical problems and at interdisciplinary boundaries with other fields of knowledge;	– Module workshop general physics" -7 cr.; – Module "Theoretical Physics" - 6 cr.; – Module "General Astronomy" - 5 cr.; – Module "Cosmology" - 9 cr.; – Module "Star Astronomy" - 9 cr.; – Module "Physics of Planetary Systems" - 9 cr.; – Module "Observational astronomy" - 9 cr.; – Module "kinematics and physics of celestial bodies- 9 cr.; – Module "Digital technology and data processing in astronomy" - 9 cr.; – Professional practice Module - 12 cr.
PC-1 Analyze and apply the physical laws of mechanics, molecular physics, electromagnetism, optics, atomic physics, nuclear physics, theoretical physics, fundamentals of radio physics and electronics for measuring and interpreting experimental data	– use radio electronic measuring devices and installations for conducting an experiment – measure the physical characteristics of objects and processes – evaluate the quality of experimental data and calculate measurement errors – analyze the results by using physical and mathematical methods of analysis – compare and interpret the results of a study by using models based on the general laws of physics	– General Physics 1 and higher mathematics – 10 cr.; – Innovative teaching methods and digital technologies – 6 cr.; – STEM - Module – 7 cr.; – General Physics 2 – 9 cr.; – General Physics 3 – 8 cr.; – Workshop on general physics – 7 cr.; – Theoretical physics– 6 cr.; – Professional practice Module - 14 cr.

PC-2 Apply physical laws to study of the structure, origin and evolution of astronomical objects and the Universe as a whole	– explain the physical structure and chemical composition of astronomical objects from protostar nebulae to metagalaxies based on physical laws – evaluate the evolutionary status of stars and classify them by properties – determine the mechanisms and processes responsible for the origin and observed structure of stars and star systems – classify stars by type of variability – determine the structure and composition of individual components of galaxies – classify galaxies by morphology – establish relationships between kinematics, physical parameters and the evolutionary status of galaxies – apply physical laws to study of the structure, origin and evolution of the Universe as a whole – explain the stages of evolution of the Universe by taking into account cosmological parameters – define variables parameters in cosmological models to determine the evolution status of the Universe – explain the accelerated expansion of the Universe based on physical laws	– STEM - Module – 7 cr.; – Physics of stars – 8 cr.; – General astronomy – 5 cr.; – Cosmology – 9 cr.; – Star astronomy – 9 cr.; – Physics of planetary systems – 9 cr.; – Kinematics and physics of celestial bodies – 9 cr.; – Professional practice Module – 14 cr.
PC-3	– plan an astronomical observations	– STEM - Module – 7 cr.;

Determine coordinates of celestial bodies and date of astronomical occasions by calculations and using of the star wheel	– draw up astronomical observation programs for robotic and automated telescopes – evaluate the effectiveness of using the instrumental time – use software packages for planning observations as GILDAS: ASTRO – calculate the orbits for minor bodies of the solar system: Comets and comet tails, asteroids – calculate the trajectories of artificial earth satellites and manned spacecraft – use a star wheel – use the modern methods of computer technology and methods of finding stars on the celestial sphere – use simulators of virtual celestial sphere – work with databases of astronomical observatories to identify the coordinates of objects and the date of observations – predict astronomical events: Iridium flares, satellite flight over the visible part of the celestial sphere – switch between different data and coordinate systems – use Julian dates in observations	– General astronomy – 5 cr.; – Star astronomy – 9 cr.; – Observational astronomy – 9 cr.; – Kinematics and physics of celestial bodies – 9 cr.; – Digital technology and data processing in astronomy – 9 cr.; – Professional practice Module – 14 cr.
PC-4 Collect and analyze of observational materials (astronomical catalogs and	– Extract information from various astronomical databases – Filter data based on the search criteria of the objects under study (stars, galaxies, etc.)	– Cosmology – 9 cr.; – Star astronomy – 9 cr.; – Physics of planetary systems – 9 cr.; – Observational astronomy – 9 cr.;

databases) for the studying of astronomical objects and the Universe as a whole	– compile SQL queries and use system commands when working with the database – compose automatic programs and scripts for data collection and analysis in the AstroPy and Phyton MySQL environment – use the Simbad, Vizier, SDSS database when working with stars and galaxies – use data from the MPC, GAIA, NASA exoplanets and ESO data catalogs when working with exoplanets and small bodies of the solar system – use data from astronomical surveys PLANK and WMAP to determine the parameters of the Universe	– Professional practice Module – 14 cr.
PC-5 Make special calculations of astronomical values and simulating physical processes occurring in outer space	– calculate and determine the physical quantities characterizing astronomical objects – build mathematical models to describe the physical properties and processes in astronomical objects – apply special processing methods in IRAF, AstroPy, GILDAS software environments: CLASS, GREG, AIPS – apply modern methods of computer algebra Mathematica and numerical methods in celestial mechanics – apply modern methods of numerical modeling of star systems and clusters using the Phi-GRAPE code	– STEM - Module – 7 cr.; – Physics of stars – 8 cr.; – Workshop on general physics – 7 cr.; – Star astronomy – 9 cr.; – Physics of planetary systems – 9 cr.; – Observational astronomy – 9 cr.; – Digital technology and data processing in astronomy – 9 cr.; – Professional practice Module – 14 cr.
PC-6 Use methods of information stream processing for	– develop software scripts for automatic analysis of big data	– Observational astronomy – 9 cr.;

astronomical data, use a computer systems of collecting, processing and storing of observational material for the study of astronomical objects and the Universe as a whole	– use modern methods of computer programming on Mathematica, Python, MatLAB for data analysis and storage – compile programs for the primary reduction of large streams of observational data – compose and edit databases based on the accumulated material of observations – compare modern systems for processing, analyzing and storing astrophysical information	– Digital technology and data processing in astronomy – 9 cr.; – Professional practice Module – 14 cr.
PC-7 Apply modern mathematical methods for analyzing of astrophysical signals and use modern digital space and ground based technologies for receiving and processing data	– perform hardware-software filtering and cleaning of the recorded signal – apply various information recording devices: Echelle spectrographs, interferometers, charge-coupled devices – produce a mathematical analysis of astrophysical signals based on Fourier, wavelet transformations, correlation communication and using specialized methods for astronomical time series using the Lomb-Scargle method as an example – apply an information-entropy approach in questions of the quantitative classification and interpretation of astrophysical signals – apply the principles of operation of the GLONASS, GPS and GALILEO navigation satellite systems in the calculations of the coordinates of ground stations and objects	– General Physics 1 and higher mathematics – 10 cr.; – Innovative teaching methods and digital technologies – 6 cr.; – Workshop on general physics – 7 cr.; – Observational astronomy – 9 cr.; – Digital technology and data processing in astronomy – 9 cr.; – Professional practice Module – 14 cr.

	– calculate the signal-to-noise ratio in various receiving antennas, including fractal ones – use satellite observations to solve research and practical issues	
PC-8 Organize a scientific research and conduct astronomical observations by using modern telescopes and receivers of cosmic electromagnetic radiation and observation methods (spectral, photometric, etc.)	– explain the principles of operation of modern telescopes and receivers (spectrograph, photometer, etc.) in the study of astronomical objects – select the required observation method (spectral, photometric, etc.) for space objects depending on the specific research task – compare the advantages and disadvantages of various observation methods (spectral, photometric, etc.) used to study space objects of various nature – use charge-coupled devices in photometric and spectral observations – monitor observational equipment using modern computer tools	– Physics of planetary systems Module – 9 cr.; – Observational astronomy – 9 cr.; – Digital technology and data processing in astronomy – 9 cr.; – Professional practice Module – 9 cr.
PC-9 Work with a specialized scientific source base, use modern computing equipment and software for conducting a scientific research work	– systematize and classify independently the scientific literature, using modern databases of scientific articles on astronomy (SAO / NASA ADS, SCOPUS, SIMBAD) – work with Latex software package for writing scientific articles – use modern scientific programs for processing and analyzing astronomical data (IRAF, Python, AIPS)	– STEM - Module – 7 cr.; – General astronomy – 5 cr.; – Star astronomy – 9 cr.; – Physics of planetary systems – 9 cr.; – Observational astronomy – 9 cr.; – Digital technology and data processing in astronomy – 9 cr.; – Professional practice Module – 9 cr.

	(Astronomical Image Processing System)) on the UNIX / LINUX operating system and MATLAB, ASTRO, CLASS, etc. on WINDOS – use super computers for numerical models of star systems.	
PC-10 Evaluate the results of scientific research in the field of physics and astronomy, prepare of conclusions and proposals for their practical application	– substantiate the choice of applying observation methods (spectral, photometric, etc.), modern analysis methods (information-entropy, spectral, etc.) and software (AstroPy, IRAF, MATLAB, ASTRO, etc.) in the study of astrophysical phenomena – summarize the results of the analysis of astrophysical phenomena by various methods – draw conclusions about the nature of astronomical objects and the universe as a whole based on the research	– STEM - Module – 7 cr.; – General astronomy – 5 cr.; – Cosmology – 9 cr.; – Star astronomy – 9 cr.; – Physics of planetary systems – 9 cr.; – Observational astronomy – 9 cr.; – Digital technology and data processing in astronomy– 9 cr.; – Professional practice Module – 9 cr.
PC-11 Present information, ideas, problems, solutions and results of scientific research in the field of physics and astronomy to specialists and non-specialists	– demonstrate and explain the physical processes of astronomical objects in the Universe using modern programs (Star Walk) – present ideas, problems, as well as the results of research at scientific seminars in physics and astronomy – to make scientific presentations on physics and astronomy	– Professional language – 9 cr.; – Professional practice Module – 9 cr. – Innovative teaching methods and digital technologies – 6 cr.;

PC-12 Acquire and use new knowledge and skills; participate in scientific discussions, write scientific papers	– use the structure and functioning of the scientific style for working with texts in the specialty in order to form a professional competencies – use scientific, reference, methodical literature in the specialty in a foreign language – create secondary scientific texts - annotation and conclusions – summarize scientific information in the form of a summary statement of the problem	Modules of General education disciplines, Modules of Core disciplines, Professional Practice.
--	---	--

Matrix of competencies formation in the educational program modules

Title of modulus	Program learning outcomes											
	A1	A2	A3	B1	B2	B3	B4	B5	C1	C2	C3	D1
GENERAL EDUCATION DISCIPLINES (GED)												
OBLIGATORY COMPONENT (OC)												
Social and Humanitarian module	A	A									C	D
Instrument module	A	A				B			C		C	D
ELECTIVE COMPONENT (EC)												
Module of socio-political knowledge	A	A									C	D
Module of cultural heritage and interpersonal communication	A	A								C	C	D
CORE DISCIPLINES (CD)												
OBLIGATORY COMPONENT (OC)												
General physics 1 and higher mathematics module	A		A	B			B	B		C		
Innovative teaching methods and digital technologies module	A		A	B	B				C	C	C	
Professional language module	A	A				B					C	D
ELECTIVE COMPONENT (EC)												
STEM-module	A	A		B	B	B	B	B	C			
Physics of stars module	A		A	B	B	B			C	C		
General physics 2 module	A		A	B	B		B			C		
General Physics 3 module	A	A	A	B	B		B		C	C		
Workshop on general physics module	A		A	B	B		B			C		
Theoretical physics module	A		A	B	B		B		C	C		
MAJOR DISCIPLINES (MD)												

OBLIGATORY COMPONENT (OC)												
General astronomy module	A		A	B	B	B			C	C		
ELECTIVE COMPONENT (EC)												
Cosmology module	A	A	A	B	B	B			C	C		
Star astronomy module	A	A	A	B	B	B			C	C		
Physics of planetary systems module	A	A	A	B	B	B	B	B	C	C		
Observational astronomy module	A	A	A	B	B	B	B	B	C	C		
Kinematics and physics of celestial bodies module	A	A	A	B	B	B	B		C	C		
Digital technology and data processing in astronomy module	A	A	A	B	B	B	B	B	C	C		
ADDITIONAL TYPES OF TRAINING(ATT)												
OBLIGATORY COMPONENT (OC)												
Physical Training module	A											D
Professional Practice module	A	A	A	B	B	B	B	B	C	C	C	D

13. Working curriculum

KEY (WORKING) EDUCATIONAL PLAN FOR SPECIALTIES 5B061100 – PHYSICS AND ASTRONOMY

Duration of study - **4 years**

Form of study - **full-time**

Awarded degree: **Bachelor of Natural Sciences on a speciality 5B061100 – Physics and Astronomy**

Cods	Title of disciplines/types of academic work	Credit s	ECTS	Term							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
GENERAL EDUCATION DISCIPLINES (GED)		29	47								
OBLIGATORY COMPONENT (OC)		21	35								
	Social and Humanitarian module	6	10								
SIK1101	Modern history of Kazakhstan (State exam)	3	5	2+1+0							
Fil2102	Philosophy	3	5				2+1+0				
	Instrument module	15	25								
IYa1103	Foreign language	6	10	0+3+0	0+3+0						
K(R)Ya 1104	Kazakh (Russian) language	6	10	0+3+0	0+3+0						
IKT1105	Information and communication technologies (in English)	3	5		2+0+1						
	Total obligatory component	21		9	9	0	3	0	0	0	0
ELECTIVE COMPONENT (EC)		8	12								
	Module of socio-political knowledge	4	6								
TPP2106	Theoretical and Applied Political Science	2	3			1+1+0					
OPS2107	General and applied Sociology	2	3			1+1+0					
	Module of cultural heritage and interpersonal communication	4	6								

Cods	Title of disciplines/types of academic work	Credits	ECTS	Term							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
KRYaK2108	Culture of speech and language communication	2	3			1+1+0					
PMK2109	Psychology of interpersonal communication	2	3			1+1+0					
	Total elective component	8		0	0	8	0	0	0	0	0
CORE DISCIPLINES (CD)		69	109								
OBLIGATORY COMPONENT (OC)		20	32								
	General physics 1 and higher mathematics module	10	16								
MF1201	Mechanics and molecular physics. Part 1. Mechanics (<i>EEEE</i>)	3	5	2+0+1							
EM2202	Electricity and magnetism, Optics. Part 1. Electricity and magnetism	4	6			2+1+1					
MA1205	Mathematical analysis.	3	5	1+2+0							
	Innovative teaching methods and digital technologies module	6	10								
TMOFA3204	Theory and methods of teaching physics and astronomy	3	5						1+2+0		
ORE4205	Fundamentals of radio physics and electronics	3	5							1+1+1	
	Professional language	4	6								
POK(R)Ya2206	Professionally-oriented Kazakh (Russian) language	2	3			0+2+0					
POIYa2207	Professionally-oriented foreign language	2	3				0+2+0				
	Total of obligatory component	20		6	0	6	2	0	3	3	0
	ELECTIVE COMPONENT (EC)	49	77								

Cods	Title of disciplines/types of academic work	Credits	ECTS	Term							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
	Main disciplines of the educational program										
	STEM-module	7	11								
FOE3208	Physical bases of electronics	2	3						1+1+0		
KMFPS3209	Computer modeling of physical processes	2	3					1+0+1			
AGLA1210	Analytical geometry and linear algebra	3	3		1+2+0						
	Physics of stars	8	12								
OA2211	Fundamentals of Astrophysics	4	6				2+2+0				
GA3212	Galactic astronomy	4	6					2+2+0			
	General physics 2	9	15								
MF1213	Mechanics and molecular physics. Part 2. Molecular Physics (EEEE)	3	5		2+0+1						
Opt2214	Electricity and magnetism, Optics. Part 2. Optics	3	5				2+0+1				
AF3215	Atomic physics	3	5					1+1+1			
	General Physics 3	8	12								
YaF3216	Nuclear physics	4	6						1+2+1		
FKS3217	Condensed state physics	4	6						1+2+1		
	Workshop on general physics	7	11								
PM1219	Workshop-mechanics	2	3	0+2+0							
PMF1220	Workshop- Molecular physics	2	3		0+2+0						
PEM2221	Workshop - Electricity and magnetism	1	2			0+1+0					
PO2222	Workshop – Optics	2	3				0+2+0				
	Theoretical physics	6	9								
OVT A2223	Fundamentals of vector-tensor analysis	3	5				1+2+0				

Cods	Title of disciplines/types of academic work	Credits	ECTS	Term							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
ED3224	Electrodynamics	4	6					2+2+0			
KM3225	Quantum Mechanics	3	5						2+2+0		
	Total of elective component of the educational program	49		3	7	1	12	13	13	0	0
MAJOR DISCIPLINES (MD)		32	53								
OBLIGATORY COMPONENT (OC)		5	8								
	General astronomy	5	8								
OA1301	General Astronomy (<i>EEEA</i>)	3	5		1+2+0						
Ast2302	Astrometry (<i>EEEA</i>)	2	3			1+1+0					
	Total of obligatory component	5		0	3	2	0	0	0	0	0
ELECTIVE COMPONENT (EC)		27	45								
	Cosmology	9	15								
SEV4303	Structure and evolution of the Universe	3	5							1+2+0	
OK4304	Fundamentals of Cosmology	3	5							1+2+0	
VA4305	Extragalactic astronomy	3	5							1+2+0	
	Star astronomy	9	15								
FPZ4306	Physics of variable stars	3	5							1+2+0	
SEZ4307	The Structure and Evolution of Stars	3	5							1+2+0	
DZS4308	Dynamics of stellar systems	3	5							1+2+0	
	Physics of planetary systems	9	15								
FP3309	Physics of Planets	3	5					1+1+1			
FSSS3310	Physics of the Sun and the Solar System	3	5						1+1+1		
SMIP3311	Spectral methods of Planets study	3	5						1+1+1		
	Observational astronomy	9	15								
VR4303	Radio astronomy	3	5					1+2+0			
OA4304	Fundamentals of Astrophotometry	3	5							1+2+0	
PEA4305	Semiconductor electronics in astrophysics	3	5							1+2+0	

Cods	Title of disciplines/types of academic work	Credits	ECTS	Term							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
	Kinematics and physics of celestial bodies	9	15								
NM3306	Celestial mechanics	3	5					1+2+0			
NOG3307	Nonstationary Objects of Galaxy	3	5						1+2+0		
VFKI3308	Physics of cosmic radiation	3	5							1+1+0	
	Digital technology and data processing in astronomy	9	15								
TsKS3309	Digital space communications	3	5					1+1+1			
KRR3310	Space Radio location and Radio navigation	3	5							1+2+0	
IEAAS4311	Informational entropy analysis of astrophysical signals	3	5						2+1+0		
	Total of elective component	27		0	0	0	0	6	6	15	0
	Total of theoretical studies	130	209	18	19	19	18	19	19	18	0
ADDITIONAL TYPES OF TRAINING(ATT)		22									
	Physical Training Module										
FK	Physical Training	8		0+0+2	0+0+2	0+0+2	0+0+2				
	Professional Practice Module	14									
UP	Educational internship	4			2		2				
PrP	Industrial internship	8					2		1		5
PdP	Pre-diploma internship	2									2
	Total on additional types of training	22		2	4	2	6	0	1	0	7
FINAL ATTESTATION		3									
GES	Specialty state examination	1									1
NZDR	Writing and defense of the thesis	2									2

Cods	Title of disciplines/types of academic work	Credits	ECTS	Term							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
TOTAL		155		20	23	19	23	19	23	18	10

CONTENT OF EDUCATIONAL MODULES OF DISCIPLINES

GENERAL EDUCATION DISCIPLINES (GED) – 29 credits

OBLIGATORY COMPONENT (OC) – 21 credits

SOCIAL AND HUMANITARIAN MODULE – 6 credits

Common cultural competencies:

- to formulate the main stages of the modern history of progressive Kazakhstan statehood development, in the context of the world and Eurasian historical process;
- 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;
- to represent social and ethical values based on socio-legal norms and tolerance to various cultural and confessional traditions;
- Work in a group and a team, communicate effectively with colleagues, supervisors; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Modern history of Kazakhstan – 3 credits

Prerequisites: no.

Postrequisites: no.

As a result of studying the discipline, a student is able to:

- correlate individual phenomena and events of the historical past of Kazakhstan with the general paradigm of the world historical development of human society through a critical analysis;
- identify historical patterns of development of society, paying attention to the study of historical originality;
- analyze complex historical processes, phenomena and the role of historical personalities in the history of modern Kazakhstan.
- master the techniques of historical description and analysis of the causes and consequences of the events of modern history of Kazakhstan;
- classify historical sources reflecting the features of the modern history of Kazakhstan;
- systematize the conceptual foundations of the study of modern history of Kazakhstan;
- compare the ideas of continuity and consistency of historical and cultural development, the deep roots of the spiritual heritage of Kazakhstan;
- reveal the importance of the formation of historical consciousness and ideological principles in accordance with national priorities;
- predict possible solutions to contemporary problems based on an analysis of the historical past and reasoned information;
- objectively and comprehensively comprehend the advantages, features and significance of the Kazakhstan development model;
- describe the origins and developments of the idea of “Mangilik Yel”;
- use historical knowledge to analyze youth policy and address the issue of patriotism.

Studied topics:

1. Conceptual framework for the study of national history.
2. Liberation movements in construction of a national state.

3. Origins, continuity and evolution of the Kazakh statehood. Historical origins of the formation of the Soviet Kazakhstan.
4. Struggle for independence in Kazakhstan in the early twentieth century. Alash movement and its leaders.
5. Formation and modernization of the Soviet Kazakhstan. Contradictions and consequences of Soviet reforms in Kazakhstan in the second half of the twentieth century.
6. The policy of "restructuring" in Kazakhstan. Formation and development of independent Kazakhstan.
7. Formation of State structure.
8. Kazakhstan model of economic development.
9. Kazakhstan is a state recognized by the modern world.
10. Ethno-demographic processes and the strengthening of interethnic agreement.
11. Activity and role of the First President of the Republic of Kazakhstan N.A. Nazarbayev in the creation and formation of an independent Kazakhstan.
12. The policy of forming a new historical consciousness and worldview of the people of the Great Steppe.
13. Strategy "Kazakhstan-2050" - determining the way of democratization of social and political life and renewal.
14. Continuity “Kazakh Yeli” with countries on the territory of “Uly Dala”.
15. 25th anniversary of Independent Kazakhstan. The national idea “Mangilik Yel” is the basis for the consolidation of Kazakhstani society.

Philosophy – 3 credits

Prerequisites: SIK1101 – Modern history of Kazakhstan.

Postrequisites: no.

As a result of studying the discipline, a student is able to:

- describe the main content of ontology and metaphysics in the context of the historical development of philosophy;
- explain the specifics of the philosophical understanding of reality;
- justify the worldview as a product of philosophical understanding and study of the natural and social world;
- classify methods of scientific and philosophical knowledge of the world;
- interpret the content and specific features of the mythological, religious and scientific worldview;

- substantiate the role and importance of key world outlook concepts as values of the social and personal being of a person in the modern world;
- analyze the philosophical aspect of media texts, socio-cultural and personal situations to substantiate and make ethical decisions;
- formulate and correctly argue their own moral position in relation to the actual problems of modern global society;
- conduct a study that is relevant to identify the philosophical content of problems in the professional field and present the results for discussion.

Studied topics:

1. The emergence and development of philosophy. The subject and method of philosophy.
2. Historical types of philosophy.
3. Basic philosophical understanding of the world.
4. The problem of being. Ontology and metaphysics.
5. Consciousness and language.
6. Cognition and creativity.
7. Scientific and extra-scientific knowledge. Science and technology.
8. Philosophy of man and value world.
9. Man. Life and death. Meaning of life.
10. Ethics. The philosophy of values.
11. Freedom.
12. Aesthetics. Perception and creation of beauty.
13. Society and culture.
14. Philosophy of history.
15. “Mangilik Yel” and “Rukhani Zhangyru” – philosophy of new Kazakhstan.

INSTRUMENT MODULE– 15 credits

Common cultural competencies:

- to demonstrate the competent use of language and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena;
- to represent social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;
- search and use of information necessary for the effective implementation of professional tasks, professional and personal development; set a goal and choose ways to achieve it;
- work in a group and a team, communicate effectively with colleagues and management; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions;

As a result of studying the discipline, a student is able to:

- competently use linguistic and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international scene;
- build an oral and written statement in different communicative situations, to understand and analyze the structural and semantic organization of a scientific text;
- perform various text operations: describe, summarize information;
- search for information necessary for the effective performance of professional tasks;
- apply information and communication technologies in professional activities;
- use information and communication technologies in scientific and practical activities, self-education and the achievement of other goals.

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;

-innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Foreign language– 6 credits

Prerequisites: no.

Postrequisites: POIYa2207 Professionally-oriented foreign language.

As a result of studying the discipline, a student is able to:

- reproduce the orthoepic, spelling, stylistic norms of a foreign language;
- use the features of professional oral and written scientific speech in a foreign language;
- justify the strategy and tactics of speech communication in the field of professional interaction;
- speak with an oral message;
- build verbal and written statements in different communicative situations;
- understand and analyze the structural and semantic organization of a scientific text;
- perform various operations with the text: describe, summarize information;
- apply the technology of interpretation and analysis of the texts of scientific literature in the specialty in a foreign language;
- build work with information in the global computer networks and corporate computer systems in English;
- competently use language and cultural linguistic knowledge for communication in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena.

Studied topics:

1. Grammar: reading rules and word formation.
2. Grammar: all parts of speech.
3. Grammar: valid and passive voice.
4. Grammar: structure of all types of sentences.
5. Methods of transmitting passive constructions in their native language.
6. Subjunctive mood.
7. The participial momentum.

8. Infinitive constructions.
9. The sacrament constructs.
10. Gerundial designs.
11. Reading, writing, speaking and listening on topics: acquaintance, family, home, weather, friends and friendship, travel, work, hobby.
12. Reading, writing, speaking and listening on the topics: my country, my city, Astana, countries, cities and people of the world, nature.
13. Reading, writing, speaking and listening on topics: famous people of Kazakhstan, the role of Kazakhstan in the world.
14. Reading, writing, speaking and listening on topics: my future profession.

Kazakh (Russian) language – 6 credits

Prerequisites: no.

Postrequisites: POK(R)Ya2206 Professionally-oriented Kazakh (Russian) language, KRYaK2108 Culture of speech and language communication.

As a result of studying the discipline, a student is able to:

- make the correct choice and use language and speech means on the basis of knowledge of a sufficient volume of lexicons, a system of grammatical knowledge, and pragmatic means of expressing intentions;
- transfer the factual content of texts, formulate their conceptual information, describe output knowledge (pragmatic focus) of the entire text, as well as of its individual structural elements;
- interpret information of the text, explain in the volume of certification requirements the style and genre specificity of the texts of the socio-cultural, socio-political, official business and professional areas of communication;
- request and report information in accordance with the situation of communication, evaluate actions and actions of participants, use information as a tool to influence an interlocutor in situations of knowledge and communication in accordance with certification requirements;
- build programs of speech behavior in situations of personal, social and professional communication in accordance with the norms of language, culture, the specifics of the sphere of communication, certification requirements;

- discuss ethical, cultural, socially significant problems in the discussions, to express their point of view, to defend it reasonably, to critically evaluate the opinion of interlocutors;
- participate in communication in various situations of different areas of communication in order to realize their own intentions and needs (everyday, educational, social, cultural), declaring about them ethically correctly, meaningfully complete, lexico-grammatically and pragmatically adequate to the situation;
- compile household, socio-cultural, and official business texts in accordance with generally accepted standards and functional orientation, using adequate lexical-grammatical and pragmatic material of a certain certification level, which is adequate for the purpose set.

Studied topics:

1. Scientific style: substrates, genres, style and language features.
2. Offer as a minimal communicative unit. Features sentences in the scientific style of speech.
3. The concept of meaning-speech situation (type of scientific information). Text. The main features of the text.
4. Types of connectivity in the text. Functional-semantic types of text. Structural and semantic articulation of the text.
5. Role of a sentence in a text. Ways to develop information in the text.
6. Unidirectional and multidirectional texts.
7. Parallel way of developing information. Chain way to develop information in the text.
8. Basics of scientific text compression. Basic and additional text information.
9. Outline text. Types of plan (call-up, question, abstract).
10. Synopsis. Types of abstract. Common abbreviation rules.
11. Secondary texts of scientific style.
12. Abstract as a secondary text genre. Annotation structure. Language means annotations.
13. Bibliographic description.
14. Abstract as a secondary text genre. Types of essay. Language design essay.
15. Oral scientific speech. Monologue. Dialogue. Polylog Speech strategies. Educational and scientific discussion.

Information and communication technologies – 3 credits

Prerequisites: no.

Postrequisites: KMFPS3210 Computer modeling of physical processes, IEAAS4308 Information –entropy Analysis of Astrophysical Signals, TsKS3309 Digital space communications.

As a result of studying the discipline, a student is able to:

- explain the purpose, content and development trends of information and communication technologies, justify the choice of the most appropriate technology to solve specific problems;
- explain the methods of collecting, storing and processing information, how to implement information and communication processes;
- describe the architecture of computer systems and networks, the purpose and functions of the main components;
- use information Internet resources, cloud and mobile services for searching, storing, processing and distributing information;
- analyze and justify the choice of methods and means of protecting information;
- using digital technologies to develop data analysis and data management tools for various activities;
- carry out project activities in the specialty with the use of modern information and communication technologies.

Studied topics:

1. The role of ICT in key sectors of social development. ICT standards.
2. Introduction to computer systems. Computer systems architecture.
3. Software. Operating Systems.
4. Human-computer interaction.
5. Database systems.
6. Data analysis. Data management.
7. Networks and telecommunications.
8. Cybersecurity.
9. Internet technology.
10. Cloud and mobile technologies.
11. Multimedia technology.
12. Smart technology.

13. E-technology. Electronic business. Electronic learning. Electronic government.
14. Information technology in the professional field. Industrial ICT.
15. Prospects for ICT development

ELECTIVE COMPONENT (EC) – 8 credits

MODULE OF SOCIO-POLITICAL KNOWLEDGE – 4 credits

Common cultural competencies:

- 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;
- 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;
- to represent social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;
- work in a group and a team, communicate effectively with colleagues and management; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions;

As a result of studying the module, a student is able to:

- to adequately navigate in various socio-economic, political and emergency situations, political and emergency situations;
- objectively and comprehensively interpret the advantages, features and significance of the Kazakhstan development model;
- to analyze and evaluate socially significant phenomena, events, processes; to understand and analyze socially significant problems and processes, to apply the basic principles and methods of social sciences in solving social and professional problems;
- build the foundations of sociohumanitarian knowledge, understanding of the driving forces and laws of the historical and socio-cultural process, the socio-political organization of society;

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Theoretical and Applied Political Science – 2 credits

Prerequisites: SIK1101 – Modern history of Kazakhstan.

Postrequisites: no.

As a result of studying the discipline, a student is able to:

- describe the features of the organization and functioning of political institutions (institutions of representation and coordination of interests);
- demonstrate an understanding of the mechanisms and principles of the functioning of political power, political institutions, domestic, foreign, world politics and international relations;
- demonstrate an understanding of the nature and laws of the functioning and development of politics, its role in various spheres of society;
- justify the relationship of political systems and political regimes;
- to assess the degree of objectivity of political information from various sources, to argue with conviction to express their citizenship, to evaluate facts, events, phenomena based on the analysis of political strategy and national interests of modern states;
- justify the leading role of identity (national, civil) as a factor in ensuring the national security of the Republic of Kazakhstan;
- identify the nature of sociopolitical conflicts and assess their legitimacy;
- generate new ideas and apply to a changing political reality;

- use of methods for analyzing modern political processes taking place in the world and in the Republic of Kazakhstan;
- the formation of the political consciousness and political culture of students.

Studied topics:

1. The main stages of development of political knowledge in the history of civilization.
2. Politics in the structure of public life.
3. Power as a political phenomenon.
4. Subjects of policy.
5. Political systems of the present.
6. Political regimes.
7. Elections and electoral systems.
8. State and civil society.
9. Political parties and party systems, socio-political movements and organizations.
10. Political development and modernization.
11. Conflict and crisis situations in politics.
12. Political culture and political ideology.
13. World politics and modern international relations.
14. The main priorities of the foreign policy of the Republic of Kazakhstan.
15. Development Strategy of Kazakhstan until 2050.

General and applied Sociology – 2 credits

Prerequisites: SIK1101 – Modern history of Kazakhstan.

Postrequisites: no.

As a result of studying the discipline, a student is able to:

- determine objects of the study of sociology (society, social organizations, social groups, individuals, etc.) to explain the social reality;
- explain key sociological ideas and theories;

- describe social structure and stratification of society, distinguish and analyze the degree of social inequality;
- reveal the mechanism of formation of public opinion and consciousness in society;
- analyze the characteristics of social institutions in the modernization of Kazakhstani society;
- understand and explain social interactions, phenomena and processes, social changes in the world based on macro- and microsociological theories;
- interpret the basic sociological concepts and theories in order to study social processes;
- demonstrate the ability to find available sources of sociological information, compile and analyze data;
- master the applied methods of sociological research, be able to plan, organize and conduct mini-studies on student projects;
- develop the skills of analyzing texts and writing essays, discussions, effective work in a group, presentation of research results.

Studied topics:

1. Sociology in understanding the social world.
2. Introduction to sociological theory.
3. Social structure and stratification.
4. Socialization and identity.
5. Mass media, technology and society.
6. Sociology of ethnicity and nation.
7. Religion, culture and society.
8. Education and social inequality.
9. Family and modernity.
10. Deviation, crime and social control.
11. Economy, globalization and labor.
12. Health and medicine.
13. Population, urbanization and social movements.
14. Sociological research.
15. Social change: the latest sociological debate.

MODULE OF CULTURAL HERITAGE AND INTERPERSONAL COMMUNICATION – 4 CREDITS

Common cultural competencies:

- 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;
- 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;
- to demonstrate the competent use of language and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena;
- to represent social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;
- work in a group and a team, communicate effectively with colleagues and management; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions;

Professional competencies:

- use information and communication technologies in their professional activities;
- independently acquire and use new knowledge and skills; participate in scientific discussions, write scientific articles.

As a result of studying the module, a student is able to:

- 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; to the perception, analysis, synthesis of information, setting goals and choosing ways to achieve it
- develop programs for solving conflict situations in society, including in professional society
- carry out research project activities in various areas of communication, generate socially valuable knowledge, present it
- summarize the results of mental, historical-typological, interpersonal analysis to determine the place of professional activity in the cultural and historical paradigm

- to assess and possess the skills of respect for the cultural heritage and man; information on the driving forces of the psychological process
- communicate on the content and problems of the specialty both with colleagues at work and with representatives of the general public, including from other countries in a foreign language

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Culture of speech and language communication– 2 credits

Prerequisites: SIK1101 Modern history of Kazakhstan, OPS2111 General and applied Sociology, TPP2110 Theoretical and Applied Political Science, K(R)Ya 1104 Kazakh (Russian) language.

Postrequisites: POK(R)Ya2206 Professionally-oriented foreign language.

As a result of studying the discipline, a student is able to:

- interpret the concept of “culture of speech” and its main aspects: normative, communicative, ethical and rhetorical;
- explain the principles of a culture of public speaking and requirements for public speaking;
- give a public speech;
- simulate situations of oral business communication;
- compile background documents (explanatory note, protocol, extract from the protocol) and business letters.

Studied topics:

1. The concept of "culture of speech."

2. Culture speech of a business person. The main aspects of the culture of business speech. Regulatory aspect of business culture.
3. Types of language norms of the literary language.
4. The communicative aspect of the culture of business speech. Communicative qualities of speech (pithiness of speech, accuracy, clarity, purity, richness and diversity of speech).
5. The ethical aspect of the culture of speech. The functions of speech etiquette in business communication. Communication atmosphere and etiquette formulas. The system of addresses in Russian speech etiquette.
6. The role of ethics in business communication. Business rhetoric.
7. Knowledge of the art of public speaking, the necessary modern business person. Principles of culture of oratory. Requirements for public speech.
8. Target speech settings and their classification. The idea of speech. Making speech text.
9. Argumentation in oratorical speech. Classification of speech types. Information speech. Persuasive speech. Call to action.
10. The main characteristics of business communication. Principles of effective business communication.
11. The culture of oral business communication. Types of oral business communication. Presentation.
12. Modeling situations of oral business communication: “Telephone conversation”, “Business conversation”, “Negotiations”.
13. The culture of written business speech.
14. Types of business documents. Features of the preparation of personal business documents (application, power of attorney, receipt, autobiography, resume).
15. Features of the preparation of information and reference documents (explanatory note, protocol, extract from the protocol).Features of writing business letters.

Psychology of interpersonal communication– 2 credits

Prerequisites: SIK1101 Modern history of Kazakhstan, Fil2102 Philosophy.

Postrequisites: no.

As a result of studying the discipline, a student is able to:

- understand the role and place of psychological knowledge in the system of human sciences;

- analyze the basic concepts, principles and procedures of effective communication;
- analyze the signs and barriers of effective communication;
- describe the concepts of personality and interpersonal communication in the context of the formation and modernization of the national consciousness;
- analyze the value-semantic structure of the individual and highlight the main priorities for the purpose of self-determination and personal growth in the framework of the modernization of consciousness;
- use psychological knowledge for career planning and building a professional path;
- evaluate their own psychological qualities, resources and capabilities;
- justify the value and place of interpersonal communication as a factor in the development of a harmonious personality;
- develop your own strategies for effective interpersonal communication, use the skills of stress management and time management, self-presentation skills to improve personal and professional effectiveness;
- establish and maintain constructive communication with different people;
- apply different strategies for resolving conflict situations in personal and professional interaction.

Studied topics:

1. Psychology of personality and its role in the system of human sciences.
2. Motivational-need sphere of personality.
3. Emotions and emotional intelligence.
4. Volitional processes and the psychology of self-regulation.
5. Temperament and character.
6. Values, interests, norms as the spiritual basis of personality.
7. Psychology of the meaning of life and professional self-determination.
8. Psychology of career growth.
9. Psychology of communication.
10. Perceptual side of communication.
11. Interactive side of communication.
12. The communicative side of communication.
13. The concept and structure of the socio-psychological conflict.

14. Models of individual behavior in conflict.
15. Techniques and techniques for effective communication.

CORE DISCIPLINES (CD) – 69 credits

OBLIGATORY COMPONENT (OC) – 20 credits

MODULE «GENERAL PHYSICS 1 AND HIGHER MATHEMATICS» – 10 CREDITS

Common cultural competencies:

- understand and apply knowledge of the basic physical laws in nature, and their connection with the observed phenomena and processes; use inductive and deductive approaches to cognition
- work in a group and a team, communicate effectively with colleagues and management; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions
- to demonstrate critical thinking when working with new information

Professional competencies:

- analyze and apply the physical laws of mechanics and molecular physics for measuring and interpreting experimental data
- use the main electronic equipment and physical devices for measuring mechanical and electrical quantities;
- carry out the formulation, formulation and solve problems in physics;
- demonstrate skills in processing measurement results, plotting graphs and diagrams
- correctly apply the basic methods of mathematical analysis to the solution of various mathematical problems of other disciplines

As a result of studying the module, a student is able to:

- interpret basic mechanical phenomena; basic concepts and physical quantities from the course of mechanics; the basic principles and laws of mechanics, their logical content, mathematical expression and area of applicability
- interpret basic mathematical concepts included in this program, their interrelation, interdependence and mutual influence not only among themselves, but also with other mathematical disciplines
- explain, find, formulate and solve actual and significant problems of fundamental and applied mathematics
- solve the problem, apply classical mathematical models to the task, justify the correctness of the mathematical model
- measure the physical characteristics of objects and processes
- evaluate the quality of experimental data and calculate measurement errors
- analyze the results by using physical and mathematical methods of analysis
- compare and interpret the results of a study by using models based on the general laws of physics

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Mechanics and molecular physics. Part 1. Mechanics (EEEA) – 3 credits

Prerequisites: no.

Postrequisites: MF1214 Mechanics and molecular physics. Part 2. Molecular Physics (EEEA).

As a result of studying the discipline, a student is able to:

- interpret the basic provisions, laws and methods of mechanics;
- explain basic information in the field of mechanics;
- use basic physical instruments for measuring mechanical quantities;
- set and solve the experimental problems of mechanics;

- construct mathematical models of the simplest mechanical phenomena and use the mathematical apparatus available to him for analyzing these models, including methods of computational mathematics;
- process, analyze and evaluate the obtained measurement results;
- correlate (compare) the content of specific tasks with the general laws of physics.

Studied topics:

1. Kinematics of a material point, speed, acceleration normal and tangential.
2. Kinematics of circular motion.
3. Kinematics of a solid.
4. The dynamics of the material point, Newton's laws.
5. Dynamics of the system of material points.
6. Classification of forces and interactions.
7. Gravitational force, mass inert and gravitational.
8. Inertial reference systems, Galilean relativity principle.
9. Non-inertial reference systems, inertial forces.
10. Work, potential force field, conservative forces.
11. Energy: potential energy; kinetic energy, energy conservation law.
12. Dynamics of a solid body.
13. Mechanics of liquids and gases.
14. Fluctuations.
15. Waves.

Electricity and magnetism, Optics. Part 1. Electricity and magnetism – 4 credits

Prerequisites: MF1201 Mechanics and molecular physics. Part 1. Mechanics, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics.

Postrequisites: ED3225 Electrodynamics, FOE 3209 Physical bases of electronics, PEA4305 Semiconductor electronics in astrophysics.

As a result of studying the discipline, a student is able to:

- interpret the main provisions, laws and methods of electromagnetism;
- explain basic information in the field of electromagnetism;
- use basic physical devices for measuring electrical quantities;
- set and solve the experimental problems of electromagnetism;
- build mathematical models of the simplest electromagnetic phenomena and to use the mathematical apparatus available to him for the analysis of these models, including methods of computational mathematics;
- process, analyze and evaluate the measurement results;
- correlate (compare) the content of specific tasks with the general laws of physics

Studied topics:

1. Fundamentals of the theory of electromagnetic interactions. Electrostatic Gauss Theorem.
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

Mathematical analysis.– 3 credits

Prerequisites: no.

Postrequisites: AGLA1211 Analytical geometry and linear algebra, MA2227 Mathematical analysis. Part 2

As a result of studying the discipline, a student is able to:

- interpret the basic theorems of differential and integral calculus;
- discuss the basic concepts of mathematical analysis;
- use mathematical analysis methods for solving physical and astrophysical problems;
- process, analyze and evaluate the results of calculations;
- correlate (compare) the content of specific tasks with the general principles of mathematical analysis.

Studied topics:

1. Introduction. Basic concepts of set theory, operations on them and logic symbols. Quantifiers. The set of rational numbers. The set of real numbers. Properties of real numbers set. The absolute value. Count sets, their properties. The uncountability of the set of real numbers. Principle of Mathematical induction.
2. Definition of a numerical sequence. Limit of a sequence. The properties of convergent sequences.
3. Bolzano-Weierstrass' theorem. The lower and upper limits of the sequence. Fundamental sequence. Cauchy's Convergence Criterion. Number e .
4. Definition of function. Properties of the function. Limit of functions. Theorem (the limit of function is unique). Properties of the limits.
5. One-Sided Limits. Infinite limits. Infinitesimal (Infinitely Small) and Infinitely Large functions and their properties. First and Second remarkable limits.
6. The continuity of function. Continuity on an interval. Points of discontinuity. Uniform Continuity. Cantor's Theorem.
7. The derivative of function. The relationship between differentiability and continuity. The basic rules of differentiability. One-Sided Derivatives and other derivative notations.

8. Some Differentiation Formulas. Table of derivatives of basic function. Logarithmic Derivative. The Derivatives of Functions represented in implicitly form.
9. Differentials. Properties of differential. Derivatives of Higher Orders. Higher-order differentials.
10. Fermat's theorem. Rolle's Theorem. Lagrange's theorem. Cauchy's Theorem.
11. L'Hospital's Rule. Taylor's formula. Maclaurin formula.
12. Extrema of the functions. The necessary and sufficient conditions for the existence of Extrema. Increase and decrease of function. The intervals of concavity and convexity of the graph of the function. The inflection points. Asymptotes. Analysis of function using the derivative, plotting graph of function. Some curve sketching.
13. Antiderivative. Definition of the integral. The indefinite integral. The table of basic indefinite integrals. The main properties of the indefinite integral. Integration by parts and the change of variables in the indefinite integral.
14. Integration of rational expressions. Decomposition of proper rational fraction into a sum of partial fractions. Method of undetermined coefficients. Integrability of a rational fraction in elementary functions. The Ostrogradsky method.
15. Integration of irrational expressions. Integration of linear fractional irrationalities. Integration of quadratic irrationalities. Euler substitutions. Integration of the differential binomial. Integrability in elementary functions of some trigonometric expressions.

MODULE «INNOVATIVE TEACHING METHODS AND DIGITAL TECHNOLOGIES» – 6 CREDITS

Common cultural competencies:

- Understand and apply knowledge of the basic physical laws in nature, and their connection with the observed phenomena and processes; use inductive and deductive approaches to cognition
- Work in a group and a team, communicate effectively with colleagues, supervisors; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions
- Demonstrate critical thinking while working with new information

Professional competencies:

- Analyze and apply the physical laws of fundamentals of radio physics and electronics for measuring and interpreting experimental data
- Apply modern mathematical methods for analyzing of astrophysical signals and use modern digital space and ground based technologies for receiving and processing data
- Present information, ideas, problems, solutions and results of scientific research in the field of physics and astronomy to specialists and non-specialists

As a result of studying the module, a student is able to:

- demonstrate and explain the physical processes of astronomical objects in the Universe using modern programs (Star Walk)
- present ideas, problems, as well as the results of research at scientific seminars in physics and astronomy
- to make scientific presentations on physics and astronomy
- to apply computer methods of collecting, storing and processing information used in the field of professional activity
- recommend standard test methods
- explain the reasons and solve the tasks with the use of databases and literature
- use radio electronic measuring devices and installations for conducting an experiment
- perform hardware-software filtering and cleaning of the recorded signal
- produce a mathematical analysis of astrophysical signals based on Fourier, wavelet transformations, correlation communication and using specialized methods for astronomical time series using the Lomb-Scargle method as an example
- apply an information-entropy approach in questions of the quantitative classification and interpretation of astrophysical signals
- calculate the signal-to-noise ratio in various receiving antennas, including fractal ones

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;

- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Theory and methods of teaching physics and astronomy – 3 credits

Prerequisites: MF1201 Mechanics and molecular physics. Part 1. Mechanics, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics, EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism, Opt2215 Electricity and magnetism, Optics. Part 2. Optics.

Postrequisites: PP Pedagogical internship.

As a result of studying the discipline, a student is able to:

- explain the content of the new material, based on the knowledge and experience of students;
- demonstrate the methods and means of teaching physics and astronomy;
- interpret the theoretical foundations and principles of teaching physics and astronomy;
- apply basic technologies used in teaching physics and astronomy;
- make thematic, calendar curricula, lesson plan;
- develop and conduct various forms of training;
- demonstrate skills of mastering the methods and techniques of drawing up tasks, exercises, tests on various topics.

Studied topics:

1. Scientific-theoretical and methodological foundations of teaching physics and astronomy.
2. Theory and methods of teaching physics, subject of the discipline, goals and objectives.
3. Types of organization of studies in physics and astronomy in secondary schools.
4. Organization of studies in physics and astronomy in high school.
5. Methods of studying the main topics of the course in physics and astronomy.
6. The system of methods and tools for teaching physics and astronomy.
7. Didactic principles of teaching physics.
8. Methods of teaching physics.
9. Methods of intensification of teaching physics.

10. Types of lessons in physics.
11. Types of educational physical experiment.
12. Monitoring and evaluation of knowledge and skills.
13. Planning training classes in physics. Calendar plan. Lesson plan.
14. Methodical issues of the main sections of physics and astronomy.
15. Using a computer to study physics.

Fundamentals of Radio Physics and Electronics – 3 credits

Prerequisites: EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism.

Postrequisites: FOE 3209 Physical bases of electronics, PEA4305 Semiconductor electronics in astrophysics.

As a result of studying the discipline, a student is able to:

- demonstrate the basic radio elements;
- explain the principle of operation of basic analog and digital devices, their circuitry, structure and principle of organization of electronic measuring devices;
- apply electronic equipment in practice;
- measure electrical quantities using general-purpose radioelectronic equipment;
- make the simplest electronic functional units using integrated circuits and discrete elements;
- process, analyze and evaluate the measurement results;
- correlate (compare) the content of specific tasks with the general laws of physics.

Studied topics:

1. Signals, their classification, parameters.
2. Elements of linear electric circuits, source of emf, source of current.
3. Calculation of linear chains by the method of complex images.
4. Passage of pulse signals through linear circuits, transients, operator method of analysis.
5. Differentiating, integrating circuits, compensated voltage divider.

6. Electron-hole transition, its properties, semiconductor diodes, zener diodes, tunnel diodes.
7. Bipolar transistors, switching circuit.
8. Bipolar transistor as a quadrupole, parameters, equivalent circuits in different wiring diagrams.
9. Dynamic Bipolar Transistor Mode.
10. Field effect transistors.
11. Classification of electronic amplifiers, their main characteristics, parameters.
12. Amplifier feedback gain, negative and positive feedback.
13. Operational amplifiers, main characteristics, parameters.
14. Electric Signal Generators.
15. Multivibrator in self-oscillating mode.

MODULE «PROFESSIONAL LANGUAGE» – 4 CREDITS

Common cultural competencies:

- demonstrate the 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;
- search and use of information necessary for the effective implementation of professional tasks, professional and personal development; set a goal and choose ways to achieve it;
- work in a team and a team, communicate effectively with colleagues, management; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions;
- demonstrate critical thinking when working with new information;

Professional competencies:

- work with specialized literature, use modern computing equipment and software for research work;
- acquire and use new knowledge and skills; participate in scientific discussions, write scientific articles..

As a result of studying the module, a student is able to:

- use the structure and functioning of the language for working with texts in the specialty in order to form a professional world outlook;
 - use scientific, reference, methodical literature in the specialty in a foreign language;
 - create secondary scientific texts - annotation and conclusions;
 - summarize scientific information in the form of a summary statement of the problem
- Methods for evaluating the results achieved:
- verbal questioning: interview, colloquium, exam;
 - written work: test, quiz, essay, abstract;
 - control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
 - innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Professionally-oriented Kazakh (Russian) language – 2 credits

Prerequisites: K(R)Ya1104 Kazakh (Russian) language.

Postrequisites: core and major disciplines.

As a result of studying the discipline, a student is able to:

- understand the orthoepic, spelling, stylistic norms of the Kazakh / Russian language;
- to systematize the system of concepts and terms of the discipline;
- apply theoretical knowledge of the Kazakh (Russian) language in educational and professional activities;
- understand the features of professional oral scientific speech;
- determine the features of professional written scientific speech;
- justify the strategy and tactics of speech communication in the field of professional interaction;
- be able to speak with an oral message;
- build oral and written statements in different communicative situations;
- understand and analyze the structural and semantic organization of a scientific text;

- perform various operations with the text: describe, summarize information;
- demonstrate skills of mastering technology of interpretation and analysis of the texts of scientific literature in the specialty.

Studied topics:

1. Professional vocabulary. Term system of professional language. Requirements for terms.
2. Business documentation in the professional field.
3. Business relations in the professional field. Dialogue. Monologue.
4. Scientific and publicistic style of speech.
5. Grammar-style features of a professional text.
6. Thesis. Types of arguments. Types of evidence: direct, indirect, theoretical and empirical.
7. The ways of presenting the material: historical, analogy, stepped, conceptual.
8. Work with sources. Annotation. Referencing.
9. Development of skills and abilities of reading scientific literature in the specialty for the formation of professional competence.
10. Formulation of theses of a scientific article on a specialty. Compiling a glossary.
11. Work on writing a scientific article on the specialty.
12. Increase the level of speech, communicative competence in the professional sphere.
13. The development of creative writing skills on the basis of secondary scientific texts, as well as texts relating to various functional-semantic types of speech.
14. Selection of material on the topic and problem of scientific research. Rules for compiling bibliography.
15. The semantic structure of the scientific text, its various types and skills of analyzing scientific information on the basis of generalization and compression.

Professionally-oriented foreign language – 2 credits

Prerequisites: IYa1103 Foreign language.

Postrequisites: core and major disciplines.

As a result of studying the discipline, a student is able to:

to systematize the system of concepts and terms of the discipline; apply theoretical knowledge of a foreign language in educational and professional activities;

- master the functional features of oral and written professional-oriented texts;
- possess strategies of communicative behavior in situations of international professional communication;
- understand oral (monologue, dialogical) speech within professional topics;
- demonstrate practical skills in various types of speech activity in a foreign language; participate in the discussion of topics related to the specialty;
- show the ability to perceive, analyze and summarize educational and scientific information, logically and grammatically correct formulation of statements;
- independently prepare and make oral reports on professional topics, including using multimedia technologies;
- extract the necessary information from sources in a foreign language created in different sign systems (text, table, graph, diagram, audiovisual series, etc.) in typical situations of professional and business communication.

Studied topics:

1. Professional vocabulary. Term system of professional language.
2. Business documentation in the professional field.
3. Business relations in the professional field. Dialogue. Monologue.
4. Scientific and publicistic style of speech.
5. Grammar-style features of a professional text.
6. Thesis. Types of arguments. Types of evidence: direct, indirect, theoretical and empirical.
7. Work with sources. Annotation. Referencing.
8. Development of skills and abilities of reading scientific literature in the specialty for the formation of professional competence.
9. Formulation of theses of a scientific article on a specialty. Compiling a glossary.
10. Work on writing a scientific article on the specialty.
11. Increasing the level of speech, communicative competence in the professional sphere.

12. The development of creative writing skills on the basis of secondary scientific texts, as well as texts relating to various functional-semantic types of speech.
13. Selection of material on the topic and problem of scientific research. Rules for compiling bibliography.
14. The semantic structure of the scientific text, its various types.
15. Analysis of scientific information on the basis of generalization and compression.

ELECTIVE COMPONENT (EC) – 49 credits

STEM - MODULE – 7 CREDITS

Professional competencies:

- analyze and apply the physical laws of electronics for measuring and interpreting experimental data
- make special calculations of astronomical values and simulating physical processes occurring in outer space
- work with a specialized scientific source base, use modern computing equipment and software for conducting a scientific research work
- know the principles of processing information flows of astronomical data, be able to use computer systems for collecting, processing and storing;

As a result of studying the module, a student is able to:

- electronic measuring devices and installations for conducting an experiment
- analyze the results by using physical and mathematical methods of analysis
- build mathematical models to describe the physical properties and processes in astronomical objects
- apply modern methods of computer algebra Mathematica and numerical methods
- apply modern methods of numerical modeling of star systems and clusters
- use super computers for numerical models of star systems

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;

- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Physical bases of electronics – 2 credits

Prerequisites: EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism.

Postrequisites: PrP Industrial internship.

As a result of studying the discipline, a student is able to:

- demonstrate typical circuit solutions for electronic devices;
- explain the physical basis of the operation of electronic devices, their purpose and classification;
- analyze the characteristics, parameters and equivalent circuits of electronic devices;
- use electronic devices to build electronic devices;
- evaluate the suitability of various electronic devices to solve a specific problem.

Studied topics:

1. The role of physical phenomena and processes in electronics, the main directions of development of electronics.
2. Elements of the band theory of the structure of solids, the filling of zones with electrons and the division of bodies into metals, dielectrics and semiconductors.
3. Statistical laws in collectives of particles, Maxwell-Boltzmann distribution, Fermi-Dirac.
4. Statistics of electrons in metals, statistics of charge carriers in a semiconductor.
5. The law of the current masses.
6. Conductivity, mobility of charge carriers, its dependence on temperature.
7. Scattering mechanisms of free charge carriers.
8. Temperature dependence of conductivity in semiconductor and metal.
9. Diffusion current in semiconductors, total current in a semiconductor.

10. Equilibrium and nonequilibrium charge carriers.
11. Fundamentals of physics of semiconductor devices.
12. Physical fundamentals of integrated electronics.
13. Diodes. Thyristors.
14. Photovoltaic devices based on external photoelectric effect.
15. Photoelectric devices based on the internal photoelectric effect.

Computer modeling of physical processes - 2 credits

Prerequisites: MF1201 Mechanics and molecular physics. Part 1. Electricity and magnetism, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics, EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism, Opt2215 Electricity and magnetism, Optics. Part 2. Optics.

Postrequisites: PrP Industrial internship.

As a result of studying the discipline, a student is able to:

- demonstrate the results of calculations using modern visualization methods (including, in animated form);
- develop computer programs using modern Matlab mathematical modeling packages;
- analyze the physical processes and phenomena occurring in various systems;
- select and apply numerical methods for modeling various physical phenomena and approximate solving physical problems with a given accuracy;
- evaluate the accuracy of the result of a computer experiment.

Studied topics:

1. Goals, methods and approaches of modeling physical processes.
2. General description of high-level programming languages and modern integrated math packages (Matlab, Scilab, Maple, Mathematica, Mathcad).
3. Work with files.
4. Graphic representation of the results of calculations.

5. Effective algorithms for the numerical solution of algebraic equations, the division of complex numbers, the calculation of derivatives, the solution of systems of linear algebraic and differential equations.
6. Models of physical processes based on ordinary differential equations.
7. Models of physical processes based on partial differential equations.
8. Formal description of random processes.
9. General scheme of Monte-Carlo methods.
10. Modeling the movement of bodies in uniform force fields.
11. Modeling of oscillatory processes and wave movements.
12. Modeling the behavior of systems consisting of a large number of particles.
13. Modeling of phase transitions by the method of molecular dynamics.
14. Simulation of optical phenomena.
15. Simulation of quantum systems.

Analytical geometry and linear algebra – 2 credits

Prerequisites: no.

Postrequisites: OVTA2224 Fundamentals of vector-tensor analysis

As a result of studying the discipline, a student is able to:

- explain the basic concepts of analytic geometry and linear algebra;
- demonstrate analytical methods for the study of basic geometric elements and shapes;
- apply the methods of vector and linear algebra in solving professional problems;
- analyze the properties of multidimensional vector and Euclidean spaces;
- evaluate the applicability of a method for solving a specific problem.

Studied topics:

1. Vector algebra: the concept of vector operations with vectors.
2. A straight line on the plane and in space.
3. Second order lines.

4. Surfaces of the second order.
5. Operations on matrices, their properties.
6. The determinant of the matrix, its properties and calculation.
7. Minor, algebraic additions, their properties.
8. System of n linear equations with n unknowns, methods for its solution.
9. The compatibility criterion, the Kronecker-Capelli theorem.
10. Linear space, sum and intersection of subspaces, direct sum of subspaces, properties.
11. Linear operators, their properties, examples.
12. Eigenvalues and eigenvectors of a linear operator.
13. The matrix of a linear operator, its transformation in the transition to a new basis.
14. Eigenvalues and eigenvectors of a linear operator.
15. Bilinear functions and quadratic forms in Euclidean space.

MODULE «PHYSICS OF STARS» - 8 CREDITS

Professional competencies:

- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- produce special calculations of astronomical quantities and simulate the physical processes occurring in outer space;
- explain the general characteristics, physical and chemical properties of astronomical objects;
- explain the laws of education, development, structure and movement of astronomical objects;
- make special calculations of astronomical quantities;
- simulate physical processes occurring in space;

As a result of studying the module, a student is able to:

- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- independently formulate and solve problems in physics and astronomy, formulate algorithms for modeling processes occurring in outer space; to evaluate the results of research, the preparation of conclusions and proposals for their practical use;

- analyze the principles of processing information flows of data, be able to use computer systems for collecting, processing astrophysical data; analyze the physical interpretation of new experimental information in the field of astronomy (astrophysics);
- possess the mathematical apparatus and formalisms in modern theoretical astrophysics, the criteria for choosing methods for solving problems both in analytical form and using computer technologies (modern computers and corresponding software products);

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Fundamentals of Astrophysics – 4 credits

Prerequisites: OA1301 General Astronomy (EEEE).

Postrequisites: SEZ4307 The Structure and Evolution of Stars.

As a result of studying the discipline, a student is able to:

- to substantiate modern ideas about the origin, structure, basic parameters and evolution of various objects of the Universe;
- explain the principle of operation of various astrophysical instruments;
- apply modern research methods for processing and subsequent analysis of observational data;
- to classify various objects of the universe according to their observational manifestations;
- evaluate the applicability of various research methods for solving various astrophysical problems.

Studied topics:

1. Introduction. Tasks and main sections of astrophysics. Spatio-temporal scales in astrophysics.
2. The emission and absorption of electromagnetic waves in a medium. Basic photometric concepts and units.

3. The mechanism of absorption and radiation of light by matter (atoms, molecules). Formation of continuous spectra, emission and absorption spectra. Free-free transitions. Free-bound transitions. Transitions between energy levels. Ionization. Recombination. The hydrogen atom. Rydberg's formula. The Zeeman effect. The Stark effect
4. The attenuation of light when passing through matter. Properties of radiation and the basis of spectral analysis. Doppler shift of spectral lines.
5. Radiation of an absolutely black body. Fundamentals of the theory of radiation transfer. Emissivity coefficient. Coefficient of absorption and optical thickness. The transport equation and its simplest special cases.
6. Features and physical limitations of astronomical observations. The main tasks of observational astronomy. Telescopes and receivers of radiation. Physical limitations on the accuracy of astronomical measurements.
7. Methods for determining of temperature. Types of temperatures of stars. Determination of the chemical composition and density of celestial bodies.
8. Classifications of stars. Spectra of stars. Spectral classes. The Hertzsprung-Russell diagram. Mass-luminosity ratio. Star spectroscopy as a tool for determining the fundamental stellar parameters.
9. Stars. General characteristics. Types of stars. Double stars. Determination of the parameters of stars from observations of binary stars.
10. The internal structure of the stars. Evolution of stars.
11. A star named Sun. Modern ideas about the internal structure and structure of the Sun's atmosphere. Manifestations of solar activity.
12. Nonstationary stars. Their main types, representations about the nature of variability and methods of research.
13. Hot stars with features in the spectra. Stars of the types Ae / Be Herbig, Be and B [e].
14. Compact stars as a result of the final stage of the evolution of stars: white dwarfs, neutron stars, black holes. Criteria of Chandrasekhar and Oppenheimer-Volkov.
15. Interstellar medium. Its main components and observational manifestations. The nature of the main components of the interstellar medium and their role in the universe.

Galactic astronomy – 4 credits

Prerequisites: OA1301 General Astronomy (EEEE).

Postrequisites: DZS4308 Dynamics of stellar systems.

As a result of studying the discipline, a student is able to:

- demonstrate acquired knowledge for planning, modeling, astronomical experimental research;
- explain the structure and composition of individual components of our galaxy;
- establish the relationship between the kinematic and physical parameters of the galaxy populations and their evolutionary status;
- estimate the parameters of stellar populations by their spatial position in the galaxy;
- calculate the transitions between physical and astronomical systems of photometric quantities;
- choose adequate physical methods to solve specific problems.

Studied topics:

1. Coordinates in stellar astronomy. Coordinate systems. Observational data.
2. Photometric characteristics of stars. Visible and absolute stellar magnitudes. Photometric systems.
3. Determination of distances to stellar objects. Geometric methods for determining distances to celestial bodies. Middle (age-old) parallaxes. Photometric methods for determining distances to celestial bodies.
4. Spectral classification of stars. Historical information. The ICC system.
5. Diagram of Hertzsprung-Russell. The main sequences on the Hertzsprung-Russell diagram. Star evolution. Types of variable stars and the instability band.
6. Absorption of light in the galaxy. Complete and selective absorption of light. Determination of color excess in the UBV system. Model of the visible distribution of absorbing matter. Absorbing matter in our Galaxy.
7. Dissipated star clusters and stellar associations. Common characteristics of scattered clusters. Determination of excess color, distances and ages of scattered clusters.
8. HR-diagram of a scattered cluster. Dissected star clusters in the galaxy. Star associations, complexes and moving groups. Immersed clusters.
9. Main Sequences (MS). Gas-dust discs. Elements of the theory of potential and celestial mechanics. Potential energy and the virial theorem.
10. Sources of energy stars. Formation of heavy elements. Basic concepts of astrophotometry. Stellar magnitudes.

11. Degenerate stars. The relationship between mass and radius, the limiting mass of stars. Fundamentals of spectral analysis. Spectral classification of stars. The Hertzsprung-Russell diagram (HR). The main sequence.
12. The theory of the evolution of stars. Jeans instability. The composition and structure of galaxies of various types. .. Standard scenario of star formation. Dynamic balance of stars. Normal stars, white dwarfs and neutron stars. Black holes.
13. Neutron stars. Pulsars. Supernova stars. Supernova remnants and their observations. The sun is like a star. Elements of stellar astronomy. The structure of the galaxy. Classification of galaxies. Clusters of galaxies.
14. Spiral branches and star formation. Nonstationary and double stars. New stars. Elements of stellar dynamics. Evolution of galaxies. Active nuclei of galaxies. Quasars.
15. Observations of objects with a large redshift and the evolution of galaxies. Quasars. Elements of cosmology. The Hubble Act. Friedman's solution. Critical density. Standard cosmological scenario. Relic radiation. Cellular structure of the Universe.

MODULE «GENERAL PHYSICS 2» - 9 CREDITS

Common cultural competencies:

- understand and apply knowledge of the basic physical laws in nature, and their connection with the observed phenomena and processes; use inductive and deductive approaches to cognition
- demonstrate critical thinking while working with new information

Professional competencies:

- analyze and apply the physical laws of mechanics, molecular physics, electromagnetism, optics, atomic physics for measuring and interpreting experimental data

As a result of studying the module, a student is able to:

- use specialized knowledge in the field of physics for mastering specialized physical disciplines
- explain, find, formulate and solve actual and significant problems of fundamental and applied physics
- correctly correlate the content of specific tasks with the general laws of physics, apply the laws to solve physical problems and at interdisciplinary boundaries with other fields of knowledge

- measure the physical characteristics of objects and processes
- evaluate the quality of experimental data and calculate measurement errors
- analyze the results by using physical and mathematical methods of analysis
- compare and interpret the results of a study by using models based on the general laws of physics

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Mechanics and molecular physics. Part 2. Molecular Physics (EEEE) – 3 credits

Prerequisites: MF1201 Mechanics and molecular physics. Part 1. Mechanics.

Postrequisites: FKS 3218 Condensed state physics.

As a result of studying the discipline, a student is able to:

- interpret the basic statistical laws and laws of distribution, the fundamentals of thermodynamics of equilibrium processes, transport phenomena, models of ideal and real gases and their basic properties, phase transitions;
 - describe physical concepts and laws for assessing and predicting the behavior of substances in various aggregative states;
 - apply methods for solving practical problems, the foundations of which are molecular forms of motion and statistical laws;
 - use the basic knowledge of the fundamental sections of mathematics, to create mathematical models of typical professional problems;
 - summarize the results of basic theoretical knowledge of the fundamental sections of general physics for solving professional problems.
1. Molecular-kinetic theory.
 2. Perfect gas.

3. The concept of temperature.
4. The distribution of gas molecules in velocity.
5. The first law of thermodynamics.
6. The second law of thermodynamics.
7. Real gases and liquids.
8. Transport phenomena.
9. Surface phenomena in liquids.
10. Solids.
11. Waves in continuum and elements of acoustics.
12. Waves in elastic media.
13. Phase and group velocity.
14. Wave propagation in inhomogeneous media.
15. Reflection and refraction of waves at the boundary of two media.

Electricity and magnetism, Optics. Part 2. Optics – 3 credits

Prerequisites: EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism

Postrequisites: AF3216 Atomic physics

As a result of studying the discipline, a student is able to:

- demonstrate knowledge of the theoretical foundations of optical physics, the principles of mathematical description of optical phenomena, concepts and models of approximation;
- describe the principles of operation, characteristics and parameters of optical elements, devices and systems;
- use optical instruments for the study of the main phenomena of wave and quantum optics, analyze empirical data;
- analyze the conditions for observing and recording optical effects and processes;
- to develop methods for setting tasks and methods for conducting experiments using elements of optics.

Studied topics:

1. Development of ideas about the nature of light. The first laws of optics. Fermat's principle. Energy units and the relationship between them. Models of radiation sources. Brightness of the scattering surface. Illumination created by various sources.
2. The phenomena of refraction and refraction in nature. Optical fibers. Basic concepts and definitions of geometric optics. Beginning of the geometric theory of optical images. Refraction on a spherical surface. Lens. Formulas of a thin lens. Refraction on a spherical surface. Spherical mirror. Centered optical system.
3. Construction of an image in a thin/thick lens. Telescope. Microscope. Eye and sight. Illusions of perception of the image. Camera. Eyepiece. The film "Lens". Eye and sight. Optical circuit of the eye. Accommodation and adaptation.
4. The concept of colour. Colour coordinates. Synthesis of colour. Colour profiles of devices. Interference of monochromatic light. Interference of plane waves. Interference of waves emitted by two point sources. Interference experiments by the method of wave front division. Division of amplitude. Relations for the calculation of interference patterns.
5. Strips of equal slope. Strips of equal thickness. Rings of Newton. Interference of quasi-monochromatic light. Influence of the size of the source on the interference pattern. Two point sources. Dependence of the visibility of the bands on the distance between the sources. Extended source. Dependence of the visibility of bands on the width of an extended source. Aperture of interference.
6. Application of multi-beam interference. Multilayer dielectric coatings. Reception of dielectric mirrors. Enlightenment optics. Optical filters. Radiation of Vavilov - Cherenkov. Phased arrays.
7. The phenomenon of diffraction. The Huygens-Fresnel principle, its integral notation and interpretation. Principle of Babin. Fresnel zones. Diffraction at the edge of a semi-infinite screen. The spiral of Cornu. Fresnel approximation and Fraunhofer approximation. Diffraction of Fraunhofer on the slit, on the rectangular and circular holes.
8. Amplitude and phase diffraction gratings. Diffraction and spectral analysis. Spectral analysis in optics. Prism diffraction and interference spectral devices and their main characteristics: hardware function, angular and linear dispersion, resolving power, dispersion area Experiments on diffraction and interference.
9. The physical basis of the method of holographic recording of images. Holograms of Gabor and Denisyuk. Application of optical static holography. Diffraction on a multidimensional structure. The Breg-Wulf formula. The Laue method. Method

of crystal rotation. Method of powder. The concept of the structural basis factor and the atomic scattering factor. Photonic crystals.

10. The concepts of polarization in optics. Interference of polarized waves. Description of the polarization of radiation within the electromagnetic theory of light. Visual representation of linear, circular, elliptically polarized and unpolarized radiation. Natural light. The concept of Stokes parameters and the Mueller matrix. The degree of polarization. Polarizers.

11. Optics of anisotropic media. Propagation of light waves in anisotropic media: experimental facts and elements of the theory. Equation of Fresnel wave normals. Double refraction of light. Qualitative analysis of the propagation of light by means of Huygens' construction and wave normals. Beam demolition phenomena. Uniaxial and biaxial crystals.

12. The concept of gyrotropic media. Natural optical activity. Saccharometry. Anisotropy of optical properties induced by mechanical deformation, electrical, magnetic fields. Optical effects in liquid crystals. Dynamic scattering. Electrical control of birefringence. "Twist effect". The effect of the guest is the host.

13. Thermal radiation. Emissivity and absorptivity of a substance and their ratio. A model of an absolutely black body. The Stefan-Boltzmann law, the Wien displacement formula. Limitations of the classical theory of radiation. Elements of the quantum approach. Planck's formula. Optical phenomena in nature. Polar lights. Synchrotron radiation.

14. Photoluminescence. Photoelectric effect. Basic experimental regularities and their interpretation. Photons and their properties. Laws of conservation of energy and momentum in processes involving photons.

15. The Compton effect. Turbulent beam shift Optical phenomena in the atmosphere. History of the study of the rainbow. Luminescence phenomenon: basic laws, spectral and temporal characteristics, interpretation within the framework of quantum concepts. Photoluminescence. Photoelectric effect.

Atomic physics – 3 credits

Prerequisites: MF1201 Mechanics and molecular physics. Part 1. Electricity and magnetism, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics, EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism, Opt2215 Electricity and magnetism, Optics. Part 2. Optics.

Postrequisites: YaF3217 Nuclear physics.

As a result of studying the discipline, a student is able to:

- set out the fundamentals of modern physics of atoms and atomic phenomena, the basic quantum concepts;
- develop skills in the construction of quantum-mechanical models;
- use the laws of atomic physics in solving professional problems.

Studied topics:

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. Zeeman effect.
15. Absorption, spontaneous and stimulated emission. Einstein coefficients. Lasers. Boltzmann distribution and thermal equilibrium.

MODULE «GENERAL PHYSICS 3» - 8 CREDITS

Common cultural competencies:

- understand and apply knowledge of the basic physical laws in nature, and their connection with the observed phenomena and processes; use inductive and deductive approaches to cognition
- demonstrate critical thinking while working with new information

Professional competencies:

- analyze and apply the physical laws of nuclear physics and physics of condensed matter for measuring and interpreting experimental data

As a result of studying the module, a student is able to:

- use specialized knowledge in the field of physics for mastering specialized physical disciplines
- explain, find, formulate and solve actual and significant problems of fundamental and applied physics
- correctly correlate the content of specific tasks with the general laws of physics, apply the laws to solve physical problems and at interdisciplinary boundaries with other fields of knowledge
- measure the physical characteristics of objects and processes
- evaluate the quality of experimental data and calculate measurement errors
- analyze the results by using physical and mathematical methods of analysis
- compare and interpret the results of a study by using models based on the general laws of physics

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Nuclear physics – 3 credits

Prerequisites: MF1201 Mechanics and molecular physics. Part 1. Electricity and magnetism, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics, EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism, Opt2215 Electricity and magnetism, Optics. Part 2. Optics, AF3216 Atomic physics.

Postrequisites: PP Pedagogical internship.

As a result of studying the discipline, a student is able to:

- demonstrate knowledge of the properties of stable nuclei and nuclear forces, nuclear models, unstable nuclei, the interaction of nuclear radiation with matter and nuclear reactions;
- discuss issues of modern nuclear physics;
- apply skills to work with technical literature, scientific and technical reports, reference books and other information sources;
- analyze the fundamental laws of nature and the basic laws of natural sciences in professional activities;
- create estimates and engineering calculations for the results of nuclear transformations.

Studied topics:

1. The place and importance of nuclear physics.
2. Static properties of atomic nuclei.
3. Radioactivity.
4. The laws of simple and complex radioactive decay.
5. Problems and prospects of development of world and domestic energy, the role of atomic energy.
6. Thermonuclear reactions in the universe and in the laboratory.
7. Interaction of radiation with matter.
8. Interaction of heavy charged particles with matter.
9. Nuclear reactions.
10. Conservation laws in nuclear reactions.
11. Mechanisms and parameters of nuclear reactions.
12. Detectors of particles of ionizing radiation.
13. Registration of charged and neutral particles of different energies.
14. Elementary particles.

15. Particle and antiparticle models.

Condensed state physics – 3 credits

Prerequisites: MF1214 Mechanics and molecular physics. Part 2. Molecular Physics.

Postrequisites: PrP Industrial internship.

As a result of studying the discipline, a student is able to:

- interpret the basic physical mechanisms of the phenomena occurring in condensed matter;
- describe the type of crystalline structure of a solid;
- apply the obtained knowledge to calculate the parameters characterizing the structure, mechanical, thermal, electrical and magnetic properties of solids;
- analyze physical phenomena and processes characteristic of the condensed state;
- draw conclusions on the results of the study.

Studied topics:

1. Condensed state and the formation of a crystalline body.
2. Classification of a solid body by structure and properties.
3. The concept of translational symmetry.
4. Crystallographic classes and systems.
5. The interaction of the crystal with electromagnetic waves.
6. Reverse grille.
7. Weak chemical bond in solids.
8. Strong chemical bonds in solids.
9. Free electron gas in metals, electrical conductivity of metals, Hall effect, electronic heat capacity.
10. Fermi gas of free electrons.
11. Model of free electrons.

12. Model of almost free electrons.
13. Zone theory in solids: classification according to the features of the energy spectrum of electrons in solids, energy zones and the Fermi surface, the electron effective mass tensor.
14. Oscillation of a diatomic chain and its solution.
15. Defects in solid state materials.

MODULE «WORKSHOP ON GENERAL PHYSICS» - 7 CREDITS

Professional competencies:

- understand the basic physical processes responsible for the nature and observable features of space objects and phenomena;
- analyze basic information in the field of mechanics, molecular physics, electromagnetism, optics, atomic physics, fundamentals of radiophysics and electronics;
- simulate physical processes;
- carry out the formulation, formulation and solve problems in physics and astronomy;
- demonstrate the skills of processing measurement results, plotting graphs and diagrams;

As a result of studying the module, a student is able to:

- independently formulate and solve problems in physics and astronomy, formulate algorithms for modeling processes;
- measure the physical characteristics
- evaluate the quality of experimental data and calculate measurement errors
- evaluate the results of research, the preparation of conclusions and proposals for their practical use;

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;

- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Workshop - mechanics – 2 credits

Prerequisites: no.

Postrequisites: PMF1221 Workshop- Molecular physics.

As a result of studying the discipline, a student is able to:

- demonstrate work with laboratory equipment; describe the measurement results and evaluate the errors;
- apply a culture of thinking, the ability to summarize, analyze, perception of information, setting goals and choosing ways to achieve it;
- analyze the essence and theoretical interpretation of the basic physical phenomena of mechanics;
- prepare the simplest physical instruments for measuring various quantities using the methods of processing and analyzing the results of the experiment;
- analyze modern scientific problems of mechanics and understand the results of theoretical and experimental methods of testing scientific theories;

Studied topics:

1. Accurate body weighing.
2. Some methods of measurement results.
3. Determination of the volume of the body of regular geometric shape.
4. Calculation of the resistance of conductors on the geometric dimensions.
5. Determination of the speed of a bullet with a ballistic pendulum.
6. Determination of the moment of inertia of the Oberbeck pendulum by the dynamic method.
7. Determination of the coefficient of internal friction of the fluid according to the Stokes method.
8. Verification of the laws of conservation of momentum and energy on the example of the collision of bodies.
9. Determination of gravitational acceleration using an Atwood machine.
10. The Maxwell Pendulum.

11. Study of the movement of the gyroscope.
12. Measurement of the speed of a bullet.
13. Measurement of the speed of sound in the air by the method of interference.
14. Measurement of the speed of sound in the air by the standing wave method.
15. Measurement of elastic moduli from stretching.

Workshop – Molecular physics – 2 credits

Prerequisites: PM1220 Workshop- mechanics.

Postrequisites: PEM2222 Workshop- Electricity and magnetism, FKS3218 Condensed state physics.

As a result of studying the discipline, a student is able to:

- demonstrate knowledge of the basic research methods (thermodynamic or phenomenological and molecular kinetic or statistical), fundamental concepts, definitions and models used in molecular physics and their use to describe various processes;
- implement methods and technologies related to the discipline in solving physical problems and performing laboratory tasks;
- use instruments, methods for measuring the basic macroparameters of molecular systems and statistical methods for processing measurement results;
- analyze current scientific problems of molecular physics and understand the results of theoretical and experimental methods of testing scientific theories;

Studied topics:

1. Determination of the ratio of specific heats by the adiabatic method.
2. Determination of thermal conductivity of solid heat insulator.
3. Determination of the coefficient of internal friction of the fluid: according to the Stokes method, using a capillary viscometer.
4. Determination of the coefficient of internal friction of gases, the average length of the free path and the effective diameter of air molecules: using a gas meter, according to the average speed of a drip outflow of a liquid.

5. Determination of the coefficient of surface tension of the liquid: the method of droplets, the method of gas bubbles.
6. Determination of air humidity: using a condensation hygrometer with thermoelectric cooling, using an Asman aspiration psychrometer.
7. Acquaintance with statistical laws on mechanical models.
8. Determination of thermal conductivity of air.
9. Phase transitions: determination of the melting point.
10. The study of translational and rotational Brownian motion.
11. The study of the thermodynamics of sound vibrations.
12. The study of the calorimetric vessel.
13. Determination of the specific heat of the liquid.
14. Determination of the heat capacity of a solid by the calorimetric method.
15. Check Gauss distribution law.

Workshop- Electricity and magnetism – 1 credit

Prerequisites: PM1220 Workshop- mechanics, PMF1221 Workshop- Molecular physics.

Postrequisites: PO2223 Workshop- Optics, ED3225 Electrodynamics.

As a result of studying the discipline, a student is able to:

- understand the physical nature of electrical phenomena, the basic laws governing the occurrence of electromagnetic processes;
- apply these patterns to solve various physical problems of an applied nature and to conduct an experimental study of electrical phenomena;
- understand the work of the main electrical devices and use them for the quantitative measurement of electrical quantities;
- critically analyze, generalize, evaluate, and synthesize new ideas in the context of modern ideas about electricity and magnetism;
- present the results of the study of an electrical phenomenon or process, if necessary, in a project form;
- draw conclusions on the results of the study, solve experimental problems of various levels of complexity.

Studied topics:

1. Introduction lesson.
2. The measurement of resistance by the method of the ammeter and voltmeter.
3. The measurement of elementary charge. Millikan experiment.
4. The determination of the ratio of electron charge to its mass by the method of magnetron.
5. The study of the magnetic field of the solenoid using the hall sensor.
6. The study of phenomena of mutual induction. Part 1.
7. The study of phenomena of mutual induction. Part 2.
8. The definition of the work function of electrons from the metal. Part 1.
9. The definition of the work function of electrons from the metal. Part 2.
10. The study of electronic oscilloscope.
11. The resistance, power and shifts of the phase in AC circuits.
12. The study of electron-hole transition in semiconductors.
13. The study of the transistor.
14. The study of the bipolar transistor. Part 1.
15. The study of the bipolar transistor. Part 2.

Workshop- Optics – 2 credits

Prerequisites: PM1220 Workshop- mechanics, PMF1221 Workshop- Molecular physics, PEM2222 Workshop- Electricity and magnetism.

Postrequisites: AF3216 Atomic physics, PP Pedagogical Internship.

As a result of studying the discipline, a student is able to:

- demonstrate familiarization with modern measuring equipment and the principle of its operation; the main elements of safety in experimental studies;
- explain the basics of optics;
- apply a mathematical apparatus for mastering the theoretical foundations and practical use of physical methods;

- analyze experimental research methods for solving physical problems;
- to conduct an experiment using the methods of theoretical analysis of the results of observations, methods of computer simulation;

Studied topics:

1. The study of the microscope and the determination of the refractive index of glass with a microscope.
2. Studying the process of photographing.
3. Getting negative and positive.
4. Determination of the refractive index of liquid and solids using an Abbe refractometer, the calculation of the diameters of water molecules and glycerol.
5. Interference of light. Newton's rings.
6. Determination of the refractive index, dispersion and resolution of a prism using a goniometer spectrometer.
7. Diffraction on transparent and reflective gratings.
8. Studying the diffraction of Fraunhofer light. Diffraction of light in the near zone (Fresnel diffraction).
9. Determination of the refractometric characteristics of air using the Rayleigh interferometer.
10. Optical pyrometer.
11. The study of the laws of thermal radiation.
12. The study of the laws of light absorption.
13. The study of the photoelectric effect.
14. The study of the phenomenon of polarization of light.
15. Determination of Rydberg constant.

MODULE «THEORETICAL PHYSICS» - 6 CREDITS

Professional competencies:

- analyze and apply the physical laws of electromagnetism, optics, theoretical physics for measuring and interpreting experimental data
- to make special calculations of astronomical quantities;
- simulate physical processes occurring in outer space;
- carry out the formulation, formulation and solve problems in physics and astronomy.

As a result of studying the module, a student is able to:

- interpret basic observed phenomena; basic concepts and physical quantities; the basic principles and laws, their logical content, mathematical expression and area of applicability;
- compare and interpret the results of a study by using models based on the general laws of physics
- argue the own vision of the applied aspect in rigorous mathematical formulations

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Fundamentals of vector-tensor analysis – 2 credits

Prerequisites: AGLA1211 Analytical geometry and linear algebra.

Postrequisites: ED3225 Electrodynamics.

As a result of studying the discipline, a student is able to:

- describe the physical interpretation of the results of integration and differentiation of mathematical objects;

- apply curves and surfaces in space, their parameterization and internal geometry;
- analyze the basic formulas of field theory in curvilinear coordinates;
- create mathematical models of typical professional tasks.

Studied topics:

1. Vector analysis: Main concepts. System turn coordinates.
2. Multiplication of vectors. The scalar multiplication of vectors. Vector multiplication of vectors.
3. The mixed and double vector multiplication of three vectors.
4. Gradient, divergence, curl.
5. Action of the operator ∇ . Consecutive application of the operator
6. ∇ . Integration of vectors. Theorem of Gauss. Green's theorem.
7. Stokes' theorem.
8. Potential theory. Scalar potential. Vector potential.
9. Gauss's law. Poisson's equation.
10. Systems of coordinates: Curvilinear coordinates. Cartesian, spherical, cylindrical coordinates.
11. Differential vector operators.
12. Special systems of coordinates. Division of variables.
13. Tensor analysis: Introduction. Main concepts.
14. Folding. Direct multiplication.
15. Rule of the particular. Pseudo-tensors. Affinors.

Electrodynamics - 2 credits

Prerequisites: EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism.

Postrequisites: FOE3209 Physical bases of electronics.

As a result of studying the discipline, a student is able to:

- interpret, using modern information technologies, the information necessary to form judgments on relevant special and scientific problems;

- explain the correct use of general scientific and special terminology;
- apply basic theoretical knowledge to solve professional problems;
- analyze the principles of work and methods of operation of modern equipment;
- formulate the basic laws of electrodynamics.

Studied topics:

1. Introduction. Coulombs' law. Ohm's Law; Electromotive Force; Faraday's Law; The Induced Electric Field.
2. Energy in Electromagnetic Fields; Electrodynamics Before Maxwell.
3. Maxwell's Equations both in differential and integral forms.
4. Maxwell's Equations in Matter; Boundary Conditions.
5. Four-potential of a field. Equations of motion of a charge in a field. Gauge invariance.
6. Motion in a constant uniform electric field. Motion in a constant uniform magnetic field.
7. The electromagnetic field tensor. Invariants of the field.
8. The first pair of Maxwell's equations in the four dimensional form. The action function of the electromagnetic field.
9. The four-dimensional current vector. The Continuity Equation; The second pair of Maxwell's equations in the four dimensional form.
10. Energy density and energy flux. Poynting's Theorem. Energy-momentum tensor of the electromagnetic field. The energy-momentum tensor for macroscopic bodies.
11. Multipole expansion of the potential in a static case. Magnetic moments. Larmor's theorem.
12. Electromagnetic Waves in Vacuum. Solution of the D'alambert equation. Energy and Momentum in Electromagnetic Waves.
13. Retarded Potentials. Lienard-Wiechert Potentials.
14. Electric Dipole Radiation. Quadrupole and magnetic dipole radiation.
15. Radiation from a rapidly moving charge. Synchrotron radiation (magnetic bremsstrahlung).

Quantum Mechanics - 2 credits

Prerequisites: OVTA2224 Fundamentals of vector-tensor analysis, Opt2215 Electricity and magnetism, Optics. Part 2. Optics.

Postrequisites: YaF3217 Nuclear physics.

As a result of studying the discipline, a student is able to:

- formulate the basic concepts and fundamental laws of quantum theory;
- describe the general laws of quantum mechanics;
- demonstrate skills in working with scientific, educational and reference literature;
- analyze the basic quantum concepts used in the study of the microworld;
- discuss the fundamental concepts of nonrelativistic quantum mechanics.

Studied topics:

1. Introduction. Wave function and its physical sense. Superposition principle. Linear operators. Operation of Hermitian conjugation. Operators of QM. Expectation values.
2. Equation on eigen functions and eigen values. Classification of solutions. De Broglie wave.
3. Properties of eigen functions of Hermitian operators: discrete non-degenerate spectrum, discrete degenerate spectrum, continuous spectrum. Expansion of arbitrary function in basic functions.
4. Mutually commuting joint operators. Uncertainty relation.
5. Wave Schrodinger equation. Stationary Schrodinger equation. Dependence of QM values on time. Continuity equation.
6. 1D Schrodinger equation. General properties. Square potential well of infinite depth.
7. Linear Harmonic oscillator.
8. Potential barrier of infinite width. Reflection and transmission coefficients. Above-barrier reflection.
9. Potential barrier of finite width. Tunneling. Penetrability of the arbitrary barrier. Cold emission of electrons from metals.
10. Elements of the representation theory. Impulse representation of operators and wave functions.
11. Matrix Quantum Mechanics. Properties of matrix elements. General theory of angular momentum.
12. Stern-Gerlach experiment. Eigen functions and eigen values of spin $1/2$ operator.

13. 3D Schrodinger Equation for central potentials. General properties. Degeneracy. Radial equation. Quantum rotator. 3D Harmonic oscillator.
14. Hydrogen atom. Hydrogen-like systems.
15. Introduction to perturbation theory.

MAJOR DISCIPLINES (MD) – 32 credits

OBLIGATORY COMPONENT (OC) – 5 credits

MODULE «GENERAL ASTRONOMY» - 5 CREDITS

Professional competencies:

- Apply physical laws to study of the structure, origin and evolution of astronomical objects and the Universe as a whole;
- Determine coordinates of celestial bodies and date of astronomical occasions by calculations and using of the star wheel;
- explain the patterns of formation, development, structure and movement of astronomical objects;
- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- determine the coordinates of celestial bodies and the time of astronomical events using calculations and using a moving map of the starry sky;
- work with astronomical catalogs and databases;
- to make special calculations of astronomical quantities;
- simulate physical processes occurring in outer space;
- demonstrate skills of mastering the methodological aspects of teaching physics and astronomy in general, individual topics and concepts;
- carry out the formulation, formulation and solve problems in physics and astronomy;

- analyze the principles of processing information flows of astronomical data, be able to use computer systems for collecting, processing and storing;
- use telescopes and receivers of cosmic electromagnetic radiation for scientific research;
- to organize and conduct special astronomical observations using modern astrophysical instruments and methods of observation;
- demonstrate skills of processing measurement results, plotting graphs and diagrams;
- to assess the results of professional research, the preparation of conclusions and proposals for their practical use;
- analyze the physical interpretation of new experimental information in the field of astronomy (astrophysics);
- use information and communication technologies in their professional activities;
- use modern databases and information extraction methods; to be guided in the conditions of change of technology in professional activity;
- work with specialized literature, use modern computing equipment and software for research work.

As a result of studying the module, a student is able to:

- explain the physical structure and chemical composition of astronomical objects from protostar nebulae to metagalaxies based on physical laws
- evaluate the evolutionary status of stars and classify them by properties
- determine the mechanisms and processes responsible for the origin and observed structure of stars and star systems
- classify stars by type of variability
- determine the structure and composition of individual components of galaxies
- establish relationships between kinematics, physical parameters and the evolutionary status of galaxies

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

General Astronomy (EEEE) - 3 credits

Prerequisites: no.

Postrequisites: OA2212 Fundamentals of Astrophysics.

As a result of studying the discipline, a student is able to:

- set forth the basic concepts of general and spherical astronomy, the basics of astrometry and astrophysics;
- discuss the principles of operation of modern tools and methods of observation used in astronomy;
- demonstrate the application of fundamental physical laws and mathematical apparatus to explain the physical processes in various celestial objects;
- use different systems of celestial astronomical coordinates and convert coordinates from one system to another;
- substantiate the general ideas about the structure, origin and evolution of space objects.

Studied topics:

1. Introduction. Sections of astronomy. Basics of spherical astronomy.
2. The movement of the Sun on the celestial sphere. Ecliptic.
3. Time counting systems. The calendar. Julian days.
4. Apparent motions of the planets on the celestial sphere. Basic configurations of planets. Systems of the world. Synodic and sidereal periods of planetary revolution.
5. Real motions of the planets. Kepler's laws. Elements of the orbits of planets. The main tasks of celestial mechanics.
6. The motion of a material point under the action of gravitational force. The law of conservation of energy and types of orbits in the two-body problem.
7. Effects that distort the positions of the stars on the celestial sphere. Refraction. Aberration. Parallax. Distances in astronomy.
8. The motion of the Earth and the Moon. Eclipses.
9. Practical tasks of astronomy. Tasks of fundamental astrometry. Proper motions of stars.
10. Fundamentals of astrophysics. Electromagnetic radiation, studied in astrophysics. Basic concepts of astrophotometry. Magnitude scale.

11. Fundamentals of spectral analysis. Spectral classification of stars. The Hertzsprung-Russell diagram. The Doppler effect. Methods for determining of temperature. Determination of the chemical composition and density of celestial bodies.
12. Astronomical instruments and the basic methods of observation.
13. Stars. The main characteristics of stars and statistical dependencies between them. Nature and evolution of stars.
14. Our Galaxy. Determining of the distances to the stars. The composition and the structure of the Galaxy.
15. Fundamentals of extragalactic astronomy. Structure and types of galaxies. Elements of cosmology. Hubble's Law. Relict radiation. Cellular structure of Universe.

Astrometry (EEEE) - 2 credits

Prerequisites: OA1301 General Astronomy (EEEE).

Postrequisites: DZS4308 Dynamics of stellar systems.

As a result of studying the discipline, a student is able to:

- formulate and explain the principles of construction and practical implementation of celestial and terrestrial coordinate systems, the principles of time measurement by astronomical methods; demonstrate the translation of the coordinates of stars and other celestial bodies from one system to another;
- explain the principles of operation of goniometric instruments and reproduce the methods of positional observations of celestial bodies;
- apply the obtained knowledge to reduce the measured coordinates to refraction, aberration, parallax, precession and nutation; have skills in using astrometric catalogs, including their electronic versions;
- analyze mathematical models of astrometric phenomena and processes and use for this purpose the appropriate mathematical apparatus;
- collect and systematize information from various sources, evaluate its applicability for solving specific problems.

Studied topics:

1. The subject of astrometry, its main tasks, concepts and methods, new projects. The connection of astrometry with other areas of astronomy. Its practical importance.

2. The subject of astrometry, its main tasks, concepts and methods, new projects. The connection of astrometry with other areas of astronomy. Its practical importance.
3. The figure of the Earth, the geoid equation. Different systems of geographical coordinates.
4. Changes in the angular velocity of the Earth's rotation.
5. Earth coordinate system.
6. Determination of coordinate systems in modern astrometry, kinematic and dynamic methods The era of the catalog, the equinox, the dynamic equinox.
7. Determination of coordinate systems in modern astrometry, kinematic and dynamic methods The era of the catalog, the equinox, the dynamic equinox.
8. Dynamic time scales.
9. The concept of astronomical refraction. Refraction in a plane-parallel atmosphere.
10. Aberration. Change in the coordinates of the stars under the influence of refraction and aberration.
11. Deviation of a light beam in a gravitational field. Change of coordinates of the reference source in the gravitational field of the Sun.
12. The procedure of reduction of optical observations.
13. A review of practical astronomy methods.
14. Method of radiointerferometry with superlong bases (RSLB) in astrometry.
15. Space astrometry: astrometry using the Hubble space telescope.

ELECTIVE COMPONENT (EC) – 27 credits

MODULE «COSMOLOGY» - 9 CREDITS

Professional competencies:

- apply physical laws to study of the structure, origin and evolution of astronomical objects and the Universe as a whole;
- collect and analyze of observational materials (astronomical catalogs and databases) for the studying of astronomical objects and the Universe as a whole;
- explain the patterns of formation, development, structure and movement of astronomical objects;
- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- to make special calculations of astronomical quantities;
- simulate physical processes occurring in outer space;

As a result of studying the module, a student is able to:

- determine the structure and composition of individual components of galaxies.
- classify galaxies by morphological features.
- establish relationships between kinematics, physical parameters and the evolutionary status of galaxies.
- apply physical laws to the study of the structure, origin and evolution of the universe as a whole.
- explain the stages of the development of the universe taking into account cosmological parameters.
- choose permanent cosmological models to determine the evolution of the universe
- explain the accelerated expansion of the universe based on physical laws.
- extract information from various astronomical databases (DBs).
- use data from astronomical surveys PLANK and WMAP to determine the parameters of the Universe.

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;

- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Structure and evolution of the Universe - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- demonstrate the relationship and interdependence of the science of the Universe and the science of the microworld in the context of modern concepts;
- explain the processes of the evolutionary development of the Universe, using its modern models;
- argue modern ideas about the structure and evolution of the Universe;
- classify the main stages of the development of the universe;
- evaluate the applicability of various laws of physics at different stages of the Universe development.

Studied topics:

1. Star systems. The evolution of stars. The life of stars of different masses and its reflection on the diagram "spectrum - luminosity"; gravitational collapse and explosion of a white dwarf in a binary system due to the flow of a star-companion substance onto it; gravitational collapse of the nucleus.
2. Gas and dust in the galaxy. Observed characteristics of reflecting and diffuse nebulae; distribution of them near the plane of the galaxy.
3. Our Galaxy. Other galaxies. Composition - stars and star clusters, nebulae, interstellar gas, cosmic rays and magnetic fields; the structure of the Galaxy; radio emission.
4. Metagalaxy. Systems of galaxies and large-scale structure of the Universe, the expansion of the Metagalaxy, the hypothesis of the "hot Universe".
- 5 Supermassive black hole in the center of the Milky Way. Observation of the motion of stars in the center of the galaxy in an infrared telescope.

6. Classification of galaxies. Types of galaxies and their properties; redshift and determination of distances to galaxies; Hubble's law.
7. Active galaxies and quasars. Nature of activity of galaxies; the nature of quasars.
8. Clusters of galaxies. The nature of the accumulations and the role of dark matter in them; intergalactic gas and X-ray radiation from it.
9. Finiteness and infinity of the Universe. The connection between the law of universal gravitation and the ideas of the finiteness and infinity of the Universe; photometric paradox.
10. Model of the "hot Universe". The connection between the average density of matter and the law of expansion and the geometry of the Universe.
11. Accelerated expansion of the Universe and observation of supernovae in distant galaxies and the discovery of the accelerated expansion of the Universe.
12. Dark matter and dark energy. The contribution of dark matter to the mass of the Universe.
13. Evolution of perturbations of baryonic matter in the Universe.
14. Detection of planets near other stars. Invisible companions of the stars; methods for detecting exoplanets.
15. Search for life and mind in the Universe. Development of ideas about the existence of life in the Universe; The Drake formula and the number of civilizations in the galaxy.

Fundamentals of Cosmology - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- interpret the detection of the CMB radiation as evidence in favor of the Hot Universe hypothesis;
- to explain the current data on the acceleration of the expansion of the Universe as a result of the action of the “dark energy”, a type of matter, the nature of which is still unknown;
- apply acquired knowledge to study and interpret the phenomena observed in the Universe;
- to classify the main periods of the evolution of the Universe since the beginning of its expansion - the Big Bang;

– summarize the results of observational data from astrophysics in terms of cosmology.

Studied topics:

1. The law of universal gravitation.
2. Invariance principle.
3. Curved space - time. Riemannian geometry.
4. Basics of the general theory of relativity.
5. Cosmography of the Universe. Hubble's law.
6. Static models of the Universe. Cosmological constant.
7. Friedman model.
8. Cosmic vacuum. Scalar fields.
9. Scalars fields in cosmology.
10. The evolution of the Universe. Critical density.
11. Observational tests of modern cosmology.
12. Gravitational lensing and microlensing.
13. Cosmic strings. Domain walls.
14. Evolution of baryonic matter perturbations.
15. Theory of the birth of the Universe from "nothing".

Extragalactic astronomy - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- interpret the physical processes occurring in the active galactic nuclei;
- describe the structure of different types of galaxies;
- apply this knowledge to solve the specific problems of extragalactic astronomy;
- classify galaxies by morphological features, by radiation, by activity;

– evaluate the basic physical parameters of galaxies using observational data.

Studied topics:

1. Introduction. The discovery of Galaxies. The structure of our Galaxy. Metagalaxy. The scale of distances in the Universe. Cepheids, the method of combining the main sequences, regions HII, New and Supernovas. General relativity in cosmology.
2. Our Galaxy. I. Stars - the main "bricks" of the galaxy. Dependence of "mass-luminosity" and age of stars. Local speed reference system. Dependence of the chemical composition of stars on their age and position in the galaxy. Rotation of the galaxy.
3. Our Galaxy. II. Constant Orta. Interstellar medium. Line 21 cm. The rotation of the galaxy. Gas distribution. Interstellar dust. Magnetic field and cosmic rays. Interstellar molecules (Abstract, orally).
4. Properties of galaxies. I. Classification of Hubble galaxies. Elliptical galaxies. Spiral galaxies, spirals with a bridge. Wrong galaxies. Possible explanation of the Hubble classification.
5. Properties of galaxies. II. Observation of the rotation of spiral galaxies. Rotation of Galaxies and a spiral structure. The masses of galaxies. Dependence "mass-luminosity" for galaxies. Distribution of galaxies in the Universe. Clusters of galaxies.
6. Properties of galaxies. III. Expansion of the Universe. Peculiar galaxies and quasars. Absorption lines in the spectra of quasars. Radio galaxies. Seyfert galaxies. Energy sources of active galactic nuclei.
7. Elements of stellar dynamics. Distribution functions. Integrals of motion. The third integral and the galaxy. Movement of individual stars in the galaxy. Field of gravitation in the meridian of the galaxy. Resonance orbits.
8. The masses of galaxies. I. Masses of double galaxies. The virial theorem and its use for determining the masses of galaxies and their groups.
9. The masses of galaxies. II Simple models of mass distribution in galaxies. Crowns of galaxies. Possible methods for detecting crowns.
10. Interstellar medium. I. Cosmic rays and magnetic fields. Interaction of a magnetic field with a moving medium. Forces acting in the disk of the galaxy and the evolution of the disk. The equilibrium of the gas-cosmic-ray system is a magnetic field.
11. Interstellar medium. II. Limit of Horta. Halo and intergalactic medium. The leakage of cosmic rays from the galaxy. Star formation. Spiral density waves and star formation.

12. Chemical evolution of galaxies. I. Model of the evolution of stars in the vicinity of the Sun. Rapid enrichment with heavy elements at an early stage. Accretion of matter.
13. Chemical evolution of galaxies. II. Variations of the chemical composition in galaxies. A momentary cycle of matter. Isotopic composition of matter. Different rates of evolution of galaxies.
14. Metagalaxy. Cosmological theory of the hot Universe. The average density of matter in the Universe. Change in the luminosity of galaxies with time.
15. Problems of cosmology. Formation and early evolution of galaxies. Explanation of flattened galaxies. The final stage of the evolution of galaxies in the open Universe. The discovery of the accelerated expansion of the Universe. Dark matter and energy.

MODULE «STAR ASTRONOMY» - 9 CREDITS

Professional competencies:

- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- determine the coordinates of celestial bodies and the time of astronomical events using calculations and using a moving map of the starry sky;
- collect and analyze observational material (astronomical catalogs and databases) for the study of astronomical objects and the Universe as a whole;
- produce special calculations of astronomical quantities and simulate the physical processes occurring in outer space;
- work with a specialized scientific literature base, use modern computing equipment and software for research work;
- assess the results of scientific research in the field of physics and astronomy, the preparation of conclusions and proposals for their practical use;

As a result of studying the module, a student is able to:

- explain the physical structure and chemical composition of astronomical objects from protostar nebulae to the final stages of the evolution of stars based on physical laws
- evaluate the evolutionary status of stars and classify by properties
- determine the mechanisms and processes responsible for the observed origin and current structure of stars and star systems.

- categorize stars by types of variability
- use modern methods of computer technology and methods for finding stars on the celestial sphere.
- use the Simbad, Vizier, SDSS database when working with stars and galaxies.
- calculate and determine the physical quantities characterizing astronomical objects.
- apply modern methods of numerical modeling of star systems and clusters using the Phi-GRAPE code.
- use super computers for numerical models of star systems.

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Physics of variable stars - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: NOG3307 Nonstationary Objects of Galaxy.

As a result of studying the discipline, a student is able to:

- reproduce the basic concepts of the physics of variable stars;
- explain, using physical laws, observable phenomena of star variability;
- classify stars by the types of their variability;
- analyze observational data using the IRAF to determine the type of star variability;;
- evaluate the significance of the obtained research results in their own professional development and in the development of methods and approaches to the study of variable stars.

Studied topics:

1. Introduction The concept of a variable star. The main groups of causes of stellar variability. Historical overview. Basic astrophysical concepts and formulas used in the study of variable stars.
2. Designations of variable stars. The main catalogs of variable stars.
3. Pulsating variable stars. The physical mechanism of stellar pulsations. The position of pulsating stars of different types on the Hertzsprung – Ressel diagram.
4. Classical Cepheids, period – luminosity dependence.
5. The Baade – Vessellink method for determining the physical characteristics of Cepheids and other radially pulsating stars. Period – age dependence. Hertzsprung sequence.
6. Radial velocities of Cepheids. Spectral - double and eclipse Cepheids. Changes in the periods of Cepheids as a direct manifestation of stellar evolution.
7. Variables of the type RR Lyra, their role in studying the old population of the Galaxy.
8. Variables of the World of Whale type, red semi-regular and irregular variable stars.
9. Type II Cepheids in the galactic field and in globular clusters, their relationship with stars outside the main sequences on the Hertzsprung – Russell diagrams of globular clusters
10. Other types of pulsating variable stars: RV Taurus type stars, δ Shield, ZZ Cetus, β Cepheus and others.
11. Explosive and new variable stars. New stars. Physical mechanisms of outbreaks of classic and dwarf New.
12. Young eruptive variable stars: T-type stars Taurus, fuors. The relationship of the variability of young stars with the processes of accretion.
13. Stars with non-uniform surface brightness and variability due to axial rotation: variables of type BY Dragon, magnetic variables.
14. Variable stars are binary systems with compact components (black holes, neutron stars), their role for studying the processes of stellar evolution.
15. Introduction to eclipsing stars.

The Structure and Evolution of Stars - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- explain the structure and physical properties of stars on the basis of physical laws describing processes in stars;
- demonstrate the methods of studying the processes occurring in the stars;
- perform spectral analysis of stars using program "the Image Reduction and Analysis Facility" - IRAF.;
- analyze the processes taking place in the atmospheres and in the depths of stars at different stages of their development;
- know the types of stars in different evolution stages by its spectrum;
- collect and systematize information from various sources, evaluate its applicability for solving specific problems, and make a presentation on its basis.

Studied topics:

1. The role of the star in the universe. Sections of Star Astrophysics.
2. Star as a physical object.
3. Physical classification of stars: normal stars, their main features.
4. Mechanical and thermal equilibrium of stars. Thermodynamics's fundamentals of of stars. Reverse heat capacity.
5. Features of nuclear reaction of massive and low-mass stars.
6. Radiative transport of energy in stars. Characteristic of the quanta motion in the Sun and in the stars.
7. The stellar structure systems equations.
8. The atmosphere of the stars.
9. Formation of spectral lines. Emission lines in the spectra of stars.
10. The main points of the theory of stars evolution . Radius-Luminosity-Mass Dependence.
11. Stages of the star formation.
12. Stars evolution based on nuclear reaction after the main sequence, burning of helium and heavy elements.
13. The Final Stages of the Star Evolution : White Dwarfs; their boundary masses.
14. The final stages of the star evolution: the supernova explosions , the neutron stars, their boundary masses.
15. The main types of physical variable stars, and the cause of their variability.

Dynamics of stellar systems - 3 credits

Prerequisites: GA3213 Galactic astronomy.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- describe and substantiate the theoretical foundations of stellar dynamics;
- explain the current understanding of the structure and evolution of large-scale gravitating systems - star clusters, galaxies, clusters and superclusters of galaxies;
- The use of modern methods for the numerical simulation of star clusters using the code Phi-GRAPE;
- analyze output datas by using Python software with bibliography Astropy
- analyze the behavior and evolution of various gravitating systems based on their analytical and numerical models;
- collect and systematize information from various sources, evaluate its applicability for solving specific problems, and make a presentation on its basis.

Studied topics:

1. The subject of stellar dynamics. Star clusters, Open and globular stellar clusters.
2. Elliptical galaxies. Lenticular galaxies.
3. Potential theory: Poisson equation, potential-energy tensor.
4. Potential of spheroidal and ellipsoidal systems.
5. Two-Body Problem.
6. Orbits in static spherical potentials.
7. Euler and Lagrangian approach to the description of fluid motion. Phase space, particle distribution function in phase space.
8. Jeans Equations.
9. Disc dynamics and spiral structure.
10. Collisions & Encounters. The Boltzmann equation in the collisions presence.
11. Fokker-Planck equation.
12. Relaxation mechanisms.

13. Evolution of spherical stellar systems: mass loss, evaporation and ejection, lifetime, core collapse.
14. Disruption of stellar systems by high-speed encounters.
15. On the origin of the universe's large-scale structure.

MODULE «PHYSICS OF PLANETARY SYSTEMS» - 9 CREDITS

Professional competencies:

- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- collect and analyze observational material (astronomical catalogs and databases) for the study of astronomical objects and the Universe as a whole;
- produce special calculations of astronomical quantities and simulate the physical processes occurring in outer space;
- explain the laws of education, development, structure and movement of astronomical objects;
- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole.

As a result of studying the module, a student is able to:

- compile SQL queries and use system commands when working with the database.
- compile automatic programs and scripts for collecting and analyzing data in the AstroPy and Phyton MySQL environment;
- use data from the MPC, GAIA, NASA exoplanets and ESO data catalogs when working with exoplanets and small bodies of the solar system;
- calculate and determine the physical quantities characterizing astronomical objects;
- apply special processing methods in IRAF software environments.

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Physics of Planets - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: SMIP3311 Spectral methods of Planets study.

As a result of studying the discipline, a student is able to:

- formulate the main characteristics of the planets of the Solar system, their satellites, asteroids, Kuiper belt objects, comets, meteoroids and the Sun;
- describe the physical fundamentals of the research methods of planets;
- interpret the basic laws of radiation of the Sun and planets, stars;
- analyze new experimental data;
- explain the basic descriptions and properties of radio emission from the sun and planets.

Studied topics:

1. Introduction in Solar system planets.
2. Earth group planets: Mercury, Venus, Earth, Mars.
3. Earth group planets atmospheres.
4. Earth group planets' surface.
5. Research of Earth group planets by spacecrafts.
6. Giant Planets and their features.
7. Giant Planets' atmospheres.
8. Research of Giant Planets from spacecrafts.
9. Giant Planets spectra and research of methane absorption.
10. Light distribution in GP disks.
11. Scattering indicatrix and its role in radiation transfer.
12. Ordinary reflection model.
13. Semi-infinite atmosphere model.
14. Two layered model of light reflection in GP.
15. Projects of space flights to planets.

Physics of the Sun and the Solar System - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- describe the manifestations and nature of solar activity;
- substantiate the modern ideas about the internal structure of the Sun and the physical processes in it;
- explain the physical processes leading to the formation of the solar wind;
- characterize the influence of processes in the Sun on the interplanetary medium and planets;
- collect and systematize information from various sources, evaluate its applicability for solving specific problems, and make a presentation on its basis.

Studied topics:

1. General information about the Sun. The rotation of the Sun
2. General characteristics of the Solar phenomenon: the inner layers and the physical state in them, their basic physical characteristics
3. The equation of the internal structure of stars: the mass equation, the energy bond equation describing the release of energy from the nucleus
4. The equation of the internal structure of stars: the energy transfer equation for the diffusion approximation, the equation of hydrostatic equality.
5. Physical conditions in the solar core, features of nuclear reactions in the Sun: the role of the effect of quantum-mechanical tunneling, the reaction rate.
6. Nuclear reactions in the Sun: cycles of PP and CNO
7. The region of light transfer, the propagation of photons in the Sun
8. Convection area. Convection within the Sun.
9. Magnetic Field of the Sun.
10. Photosphere. Sun spots.
11. The Chromosphere and Corona. Chromospheric heating mechanism.

12. The concept of the activity of the Sun. Index and identification of Solar activity.
13. Expansion of the solar corona. Solar wind. Interplanetary magnetic field.
14. Interaction of the Solar wind with the interstellar medium. The concept of the heliomagnetosphere.
15. Solar-terrestrial connections.

Spectral methods of Planets study - 3 credits

Prerequisites: FP3309 Physics of Planets.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- formulate scientific and technical tasks;
- describe the fundamental and applied research aimed at developing new methods for spectral analysis;
- apply this knowledge to solve specific analytical problems;
- analyze the experience of using scientific and technical information in the process of conducting research;
- systematize the data of experimental studies.

Studied topics:

1. Types of spectra.
2. Spectral analysis and its use in the study of planets.
3. Spectrum of electromagnetic radiation.
4. Spectral studies in astronomy.
5. Possibilities of modern spectral analysis.
6. Principles of spectral research methods.
7. Basics of spectroscopy.
8. The ratio of electronic transitions with oscillatory, adiabatic approximation, the Franck-Condon principle and the probability of electronic-vibrational transitions.
9. Basic patterns of light absorption.
10. Spectrophotometry in the visible and ultraviolet regions.

11. The optimum value of optical density for measuring the concentration of a substance.
12. Features of accurate colorimetry.
13. Kinetic analysis and differential spectrophotometry.
14. The study of the fluorescence of objects.
15. Infrared spectrophotometry.

MODULE «OBSERVATIONAL ASTRONOMY» - 9 CREDITS

Professional competencies:

- determine coordinates of celestial bodies and date of astronomical occasions by calculations and using of the star wheel;
- collect and analyze of observational materials (astronomical catalogs and databases) for the studying of astronomical objects and the Universe as a whole;
- make a special calculations of astronomical values and simulating physical processes occurring in outer space;
- use methods of information stream processing for astronomical data, use a computer systems of collecting, processing and storing of observational material for the study of astronomical objects and the Universe as a whole;
- apply modern mathematical methods for analyzing of astrophysical signals and use modern digital space and ground based technologies for receiving and processing data;
- organize a scientific research and conduct astronomical observations by using modern telescopes and receivers of cosmic electromagnetic radiation and observation methods (spectral, photometric, etc.);
- work with a specialized scientific source base, use modern computing equipment and software for conducting a scientific research work;
- evaluate the results of scientific research in the field of physics and astronomy, prepare of conclusions and proposals for their practical application;

As a result of studying the module, a student is able to:

- plan astronomical observations.
- compile astronomical observation programs for robotic and automated telescopes.
- evaluate the effectiveness of the use of instrumental time.

- use software packages for planning observations GILDAS: ASTRO.
 - apply special processing methods in IRAF, AstroPy, GILDAS software environments: CLASS, GREG, AIPS.
 - compile programs for the primary reduction of large streams of observational data.
 - perform hardware-software filtering and cleaning of the recorded signal.
 - apply various information recording devices: Echelle spectrographs, interferometers, charge-coupled devices.
 - use satellite observations to solve research and practical issues;
 - explain the principles of operation of modern telescopes and receivers (spectrograph, photometer, etc.) in the study of astronomical objects.
 - select the required observation method (spectral, photometric, etc.) for space objects depending on the specific research task
 - compare the advantages and disadvantages of various observation methods (spectral, photometric, etc.) used to study space objects of various nature;
 - use charge-coupled devices in photometric and spectral observations;
 - monitor observational equipment using modern computer tools.
- Methods for evaluating the results achieved:
- verbal questioning: interview, colloquium, exam;
 - written work: test, quiz, essay, abstract;
 - control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;
 - innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Radio Astronomy - 3 creditis

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: NOG3307 Nonstationary Objects of Galaxy.

As a result of studying the discipline, a student is able to:

- explain the mechanisms of radio emission in astrophysical conditions;

- interpret the basic laws of radiation of the Sun and planets, stars, the Galaxy and extragalactic radio sources;
- apply this knowledge to interpret the results of observations of celestial bodies in the radio band;
- classify sources of cosmic radio emission;
- collect and systematize information from various sources, evaluate its applicability for solving specific problems.

Studied topics:

1. General information. The subject of radio astronomy. The history of the birth of radio astronomy. The first discoveries in radio astronomy. The place of radio astronomy in modern all-wave astronomy and radiophysics. Radio astronomy and astrophysics. Space objects as unique natural physical laboratories.
2. Radio emission mechanisms under astrophysical conditions I. Radio wave propagation in a plasma. Generation of radio emission by plasma oscillations. Polarization of radiation. Brake radiation of ionized gas. Cyclotron radiation. Synchrotron radiation.
3. Radio emission mechanisms under astrophysical conditions II. Curvature radiation. Radiation in the spectral lines of atoms and molecules. Molecular maser radiation. Scattering of radiation.
4. The Science of Radio Astronomy: The Sun. Radio emission from the quiet Sun. Coronal condensation. Sporadic radio emission from the sun.
5. The Science of Radio Astronomy: The Solar System. Moon. Own radio emission of planets and comets.
6. Radar of the bodies of the Solar system. The basic formulas of radar astronomy. The structure of the signal reflected from the planet. Radar meteors.
7. Interstellar environment and areas of star formation in the Galaxy I. Background galactic radio emission in the continuum. Interstellar neutral hydrogen.
8. Interstellar environment and star formation regions in Galaxy II. Zone HII. Recombination radio lines. Spectral radio lines of molecules. Giant Molecular Clouds overruns and molecular masers.
9. Discrete galactic radio sources I. Molecular shells of stars late spectral classes. Radio Stars.
10. Discrete galactic radio sources II. Radio emission of supernovae and their residues. Pulsars.
11. Extragalactic radio astronomy. Radio emission from normal galaxies in spectral lines and in the continuum. Radio galaxies and quasi-stellar radio sources.

12. Radio astronomy and cosmology. Basic information about cosmological models. Statistical calculations of radio sources. LogN – logS dependency.
13. Radio astronomy aspects problems of finding extraterrestrial civilizations. Select objects to search. Frequency selection. Selecting the moment to search for a signal. Astrophysical benefits of SETI observations.
14. Radio interferometry methods I: fundamentals. Modern (radio) interferometers. Basic radio interferometers and correlator. Simple (radio) interferometer.
15. Future radio astronomy. Square kilometre (SKA). Intensive data astronomy.

Fundamentals of Astrophotometry - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- demonstrate methods for measuring the amount of light coming from cosmic sources;
- explain the principle of operation of instruments used in astrophotometry;
- calculate the attenuation of light in the atmosphere of the Earth;
- analyze the effect of interstellar extinction on the extra-atmospheric distribution of energy in the spectra of stars, to apply the knowledge gained in practice;
- compare stellar magnitudes in different photometric systems.

Studied topics:

1. Introduction Basic concepts, values and formulas of heterochromatic photometry. Light and radiation
2. The main tasks of astrophotometry.
3. History and content of some photometric catalogs.
4. Absolutely black body and its radiation.
5. Instruments and devices for astronomical photometry.
6. Two-channel photometer. Three-channel photometer. Dual channel astrophotometer.

7. Astrophotometry carried out using charge-coupled devices. CCD device.
8. Absorption of light in the earth's atmosphere. Types of light attenuation in the atmosphere. Forbes effect.
9. The energy distribution in the spectra of stars of various spectral types. Photometry, spectrophotometry and spectroscopy.
10. Spectral classification and distribution of energy in the spectrum. Catalogs of normal spectrophotometric data.
11. UBV system and similar broadband photometric systems.
12. Mid-band photometric systems. Stromgren's system uvby β .
13. Organization, conduct and primary processing of photometric observations.
14. Calculation of the attenuation of light in the earth's atmosphere.
15. Note on heterochromic methods. Normalization and transfer of measurements to the general and standard photometric systems.

Semiconductor electronics in astrophysics - 3 credits

Prerequisites: ORE4205 Fundamentals of radiophysics and electronics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- formulate knowledge and skills in ad hoc calculations, correctly draw up electrical circuits, measure electrical quantities using measuring instruments;
- describe and measure the parameters and characteristics of semiconductor devices for astrophysics on personal computers;
- apply analytical and numerical analysis for a variety of effects in the time and frequency domain using modern software and semiconductor devices in astrophysics;
- analyze the effectiveness and optimization of semiconductor devices in astrophysics;
- systematize and classify independently technical literature, using modern educational and information technologies.

Studied topics:

1. Basics of semiconductor electronics. Types of semiconductor devices. The use of semiconductor devices in astrophysics.
2. Fundamentals of the band theory of semiconductors. Brillouin zones. Possible filling of electronic states of the valence band. The motion of electrons in a crystal under the action of an external electric field. Effective mass of charge carriers.

3. Statistics of electrons and holes in semiconductors. The density of quantum states. Fermi - Dirac distribution function. The degree of filling of impurity levels. Impurity semiconductor. Own semiconductor.
4. Generation and recombination of electrons and holes. Mechanisms of recombination. Interbandradiative recombination. Interband shock recombination. Carrier recombination through traps. Capture centers and recombination traps.
5. Contact phenomena in semiconductors. Thermoelectronic work function. Contact metal - metal. Contact potential difference.
6. Electron-hole transitions. The formation of the electron-hole transition, the contact potential difference. The capacity of the p-n junction. The influence of centers with deep levels on the capacity of the p-n junction.
7. Semiconductor diodes. Rectifier diodes. Zener diodes. Pulsed diodes. Varicaps Application diodes. Voltage-current characteristics of the diodes.
8. Diodes for amplifying and generating microwave power. Tunnel diode.
9. Photodiodes with p – i – n structure. Photodiodes Schottky. Photodiodes with heterostructures. Avalanche photodiodes. Phototransistors. Photothyristors. The main characteristics and parameters of the photoresistor.
10. Bipolar transistors. The main physical processes in bipolar transistors. Current-voltage characteristics of a bipolar transistor in active mode. Differential parameters of bipolar transistors in a common base circuit. Bipolar transistor in a common emitter circuit. The equivalent circuit of a bipolar transistor.
11. Field effect transistors. Field effect transistor with pn junction. The principle of operation and static characteristics of a field-effect transistor with a p – n junction as a gate. TIR - transistor.
12. Optocouplers. The device and principle of operation of optocouplers. Block diagram of the optocoupler. Electric model of the optocoupler. Resistor optocouplers. Diode optocouplers. Transistor Optocouplers. Thyristor optocouplers.
13. Receivers of electromagnetic radiation in astrophysics. Photocathode. PMT. Bolometers The configuration of the CCD matrix. Photographic photometry. Photoelectric photometry.
14. Characteristics, parameters and models of semiconductor photodetectors in astrophysics. The principle of operation of photodetector devices. Noise parameters of photodetectors.

15. Devices of coherent radiation in astrophysics. Structural scheme of the laser. The device and the principle of injection monolaser. Device and principle of operation of semiconductor lasers by hetero-structures, amplifiers and lasers, light-emitting diodes for fiber-optic systems.

MODULE «KINEMATICS AND PHYSICS OF CELESTIAL BODIES» - 9 CREDITS

Professional competencies:

- apply physical laws to study of the structure, origin and evolution of astronomical objects and the Universe as a whole;
- determine coordinates of celestial bodies and date of astronomical occasions by calculations and using of the star wheel;
- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- carry out the formulation, formulation and solve problems in physics and astronomy;

As a result of studying the module, a student is able to:

- determine the structure and composition of individual components of galaxies.
- classify galaxies by morphological features.
- establish relationships between kinematics, physical parameters and the evolutionary status of galaxies.
- apply physical laws to the study of the structure, origin and evolution of the universe as a whole.
- explain the stages of the development of the universe taking into account cosmological parameters.
- choose permanent cosmological models to determine the evolution of the universe
- explain the accelerated expansion of the universe based on physical laws.
- use simulators of the virtual sky sphere.
- move between time and coordinate calculation systems.

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;

- innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Celestial Mechanics - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- formulate the basic laws of the motion of celestial bodies, the elements of the orbit and the range of their changes, the types of motion of planets, satellites, asteroids, comets, artificial satellites of the Earth;
- apply the methods of numerical, analytical and qualitative studies of the motion of systems of celestial bodies in solving computational problems;
- formulate algorithms for modeling the processes occurring in outer space;
- evaluate the research results, prepare conclusions and suggestions for their practical use.

Studied topics:

1. Introduction to celestial mechanics. The subject, methods, tasks of celestial mechanics, its relation to other sections of astronomy. A short historical essay. Basic concepts of celestial mechanics. Introduction to vectors and vector mechanics.
2. Unperturbed motion. Equations of absolute motion. Equations of relative motion. Equations of barycentric motion.
3. The integrals of the relative motion.
4. Trajectory of motion (orbit). Keplerian elements of the orbit.
5. General solution of the equations of relative motion. General solution of the equations of absolute motion.
6. The types of unperturbed motion.
7. Calculation of ephemerides. Rows of elliptic motion.
8. Perturbed motion. Equations of absolute motion. Ten classical integrals.
9. The Lagrange-Jacobi equation. The virial theorem. The inequality of Sundman.
10. Perturbed motion. Equations of relative motion. Equations of motion in the Jacobi coordinates. Equations of motion in the osculating elements.

11. Approximate solution of the equations of motion. Laplace's theorems.
12. The restricted circular three-body problem. Equations of motion. The Jacobi integral. Libration points. The surfaces of Hill.
13. The restricted elliptic three-body problem. Equations of motion. Libration points. On the law of energy conservation.
14. The common three-body problem. Equations of motion and strict particular solutions. Surfaces of Sundman.
15. Introduction to astrodynamics.

Nonstationary Objects of Galaxy - 3 credits

Prerequisites: FPZ4306 Physics of variable stars.

Postrequisites: PrP Industrial internship.

As a result of studying the discipline, a student is able to:

- explain the physical nature of the nonstationarity of various celestial bodies and their systems;
- describe the physical characteristics of various non-stationary objects of the Galaxy;
- classify non-stationary objects of the Galaxy;
- collect and systematize information from various sources;
- evaluate its applicability for solving specific problems.

Studied topics:

1. Introduction. Star values and color indices of stars.
2. Luminosities and radii of stars.
3. Spectral classification. The Hertzsprung-Russell diagram.
4. Types of stellar population. Eclipsing stars. Classification of eclipsing variable stars.
5. Evolution of a close binary star. Change in the periods of eclipsing variable stars.
6. Pulsating variable stars.
7. Cepheids.
8. Stars like RR Lyra.

9. Dwarf cepheids. Miridy. Star type RV Taurus.
10. Semi-correct and irregular variable stars. Pulsational theory.
11. Variability of young stars. UV Cet type stars.
12. Flare stars. Stars such as RW in the Former T Taurus.
13. Exploding stars. Types of exploding stars.
14. Phenomena occurring during the outbreak of a new star.
15. Silent explosions. Z-type stars.

Physics of cosmic radiation - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- to characterize the subject and the basic concepts of the physics of cosmic rays;
- describe the characteristics of cosmic rays on the surface of the Earth, near the Earth's orbit and outside the heliomagnetosphere;
- explain the change in these characteristics on the way from the source to the observation point;
- compare the main models of CL origin;
- interpret the requirements for sources of KL;
- collect and systematize information from various sources, evaluate its applicability for solving specific problems.

Studied topics:

1. The subject of physics of cosmic rays, general information about CR, their role in nature and science.
2. Methods of registration CL.
3. The main characteristics of CR, characteristics on the surface of the Earth.
4. Passage of CR through the atmosphere of the Earth, primary and secondary CR, integral multiplicity.
5. Motion of charged particles in a uniform constant magnetic field.

6. Motion of charged particles in slowly varying magnetic fields.
7. Adiabatic invariants of motion of charged particles in magnetic fields.
8. The motion of CR in the magnetic field of the Earth.
9. The formation and structure of the interplanetary magnetic field.
10. The kinetic Boltzmann equation for the CR motion in the heliomagnetic field.
11. The Fokker-Planck equation for the motion of CR in the helio-magnetosphere, the modulation mechanisms of CR in the helio-magnetosphere.
12. The energy spectrum and the anisotropy of CRs on the Earth's orbit.
13. Mechanisms of acceleration CL.
14. Requirements for sources of CL.
15. Possible sources of cosmic rays of different energies, basic models of the origin of cosmic rays.

MODULE «DIGITAL TECHNOLOGY AND DATA PROCESSING IN ASTRONOMY» - 9 CREDITS

Professional competencies:

- determine coordinates of celestial bodies and date of astronomical occasions by calculations and using of the star wheel;
- use methods of information stream processing for astronomical data, use a computer systems of collecting, processing and storing of observational material for the study of astronomical objects and the Universe as a whole;
- apply modern mathematical methods for analyzing of astrophysical signals and use modern digital space and ground based technologies for receiving and processing data;
- organize a scientific research and conduct astronomical observations by using modern telescopes and receivers of cosmic electromagnetic radiation and observation methods (spectral, photometric, etc.);
- work with a specialized scientific source base, use modern computing equipment and software for conducting a scientific research work;
- evaluate the results of scientific research in the field of physics and astronomy, prepare of conclusions and proposals for their practical application;

As a result of studying the module, a student is able to:

- calculate orbits for small bodies of the solar system. comets and comet tails, asteroids.
- calculate the trajectories of artificial earth satellites, manned spacecraft.
- use simulators of the virtual sky sphere.
- predict astronomical events. flashes of iridiums, the passage of satellites over the visible part of the celestial sphere.
- move between time and coordinate calculation systems.
- build mathematical models to describe the physical properties and processes in astronomical objects.
- use modern methods of computer programming on Mathematica, Python, MatLAB for data analysis and storage.
- apply an information-entropy approach in questions of the quantitative classification and interpretation of astrophysical signals.
- apply the principles of operation of the GLONASS, GPS and GALILEO navigation satellite systems in the calculations of the coordinates of ground stations and objects.
- calculate the signal-to-noise ratio in various receiving antennas, including fractal ones;
- use satellite observations to solve research and practical issues

Methods for evaluating the results achieved:

- verbal questioning: interview, colloquium, exam;
- written work: test, quiz, essay, abstract;
- control with the help of technical means and information systems: computer testing programs, complex situational tasks; exam testing;

innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Digital space communications - 3 credits

Prerequisites: EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism.

Postrequisites: KRR3310 Space Radio location and Radio navigation.

As a result of studying the discipline, a student is able to:

- to formulate the basic principles of the propagation of electromagnetic waves in different environments;
- describe the basics of digital communication, the principle of operation of digital transceivers;
- apply the basis of basic analog, digital devices, their circuitry;
- analyze the structure and principles of organization of radio, satellite systems;
- to design the main nodes of digital communication systems.

Studied topics:

1. Introduction. Overview of Satellite Communication. Terminology of digital communication.
2. Orbits and Launching Methods. Kepler's Laws. Orbital elements.
3. The Geostationary Orbit. Earth Eclipse of Satellite.
4. Radio Wave Propagation. Atmospheric Losses. Ionospheric Effects.
5. Polarization. Antenna polarization. Polarization of Satellite Signals.
6. Types of Antennas used in Satellite Communication. Coordinate System. The Radiated Fields.
7. Basic components of the Space Segment.
8. Basic components of the Earth Segment.
9. Analog signals. Frequency modulation. Signal-to-noise ratio.
10. Digital signals. Pulse Code Modulation.
11. Digital phase modulations. Binary phase-shift keying. Quadrature phase-shift keying.
12. The Space Link. Transmission Losses. Internal and External Noises. Doppler's Effect.
13. Error Control Coding. Linear Block Codes. Cyclic Redundancy Check. Shannon Capacity.
14. Interference between Satellite Circuits. Energy Dispersal.
15. Satellite communications technology VSAT. Overview of Modems of the Satellite System: Hughes, iDirect, Gilat, SkyEdge

Space Radio location and Radio navigation - 3 credits

Prerequisites: TsKS3309 Digital space communications.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- formulate principles for the construction of radio-electronic devices and systems using the technology of radar and radio navigation;
- describe the characteristics of the studied electronic systems for location and navigation;
- apply physical models of processes and phenomena that underlie the principles of operation of radio engineering devices and systems;
- analyze the scientific and technical problems arising in the creation of electronic systems;
- design products using radar technology.

Studied topics:

1. Introduction. Basics of space navigation
2. Global Navigation Satellite System (GNSS) Technology.
3. GNSS Technologies: GLONASS and GALILEO.
4. Coordinate systems.
5. Methods for determining the location of the user.
6. GPS System Segments.
7. GPS Satellite Signal Characteristics.
8. Satellite System Acquisition, Tracking and Data Demodulation.
9. Updated GPS: DGPS, SBAS, A-GPS, and HSGPS.
10. GPS Integration.
11. Radar receivers.
12. The Radar Transmitter.
13. The application of the Kalman filter for solving a navigation task.
14. Principles of Remote Sensing.
15. Photographing the surface of the Earth of high and super high quality.

Information- entropy Analysis of Astrophysical Signals - 3 credits

Prerequisites: OA2212 Fundamentals of Astrophysics.

Postrequisites: PdP Pre-diploma internship.

As a result of studying the discipline, a student is able to:

- describe the main methods of the theory of dynamic chaos in astrophysics;
- explain the choice of information-entropy analysis for the study of astrophysical objects;
- analyze astrophysical signals of various nature by information-entrormism analysis;
- classify quantitatively astrophysical signals based on the information-entropy analysis;
- draw conclusions about the nature of the objects under study on the basis of information-entropy analysis.

Studied topics:

1. Introduction, analysis of astrophysical signals.
2. Analysis of time series.
3. Methods of the theory of dynamic chaos in astrophysics.
4. Statistical methods of signal processing.
5. Dynamic systems.
6. Nonlinear systems.
7. Fractal and multifractal analysis of astrophysical signals.
8. Determination of the fractal characteristics of interleaved signals.
9. Determination of the multifractal characteristics of interleaved signals.
10. The concepts of information and entropy.
11. Criteria for the degree of self-organization of open systems.
12. The generalized metric characteristic.
13. Information and entropy analysis of the light curves of variable stars.
14. Information and entropy analysis of solar radio emission.
15. Normalized entropy of hot stars.

ADDITIONAL TYPES OF TRAINING (ATT) – 22 credits

PHYSICAL TRAINING MODULE – 8 CREDITS

As a result of studying the module, a student is able to:

- use in life practical skills that ensure the preservation and strengthening of health, development and improvement of psychophysical abilities and qualities;
- independently maintain and develop the basic physical qualities in the process of exercising;
- use methods and means of physical training to ensure full social and professional activities;
- access the current state of physical culture and sports in the world;
- adhere to a healthy lifestyle;
- self-organization and self-education in the formation of a healthy lifestyle.

Methods for evaluating the results achieved:

- oral survey: interview, certification.

Physical Training – 8 credits

Prerequisites: no.

Postrequisites: no.

As a result of studying the discipline, a student is able to:

- formulate the state policy and the main achievements of the Republic of Kazakhstan in the field of physical culture and sports;
- understand the theoretical and methodological, hygienic and organizational foundations of physical culture and sports;
- use in life practical skills and abilities ensuring the preservation and strengthening of health, development and improvement of psychophysical abilities and qualities;
- use means of physical culture and sports for the prevention of diseases, mental well-being, development and improvement of the qualities and properties of the individual

Studied topics:

1. Physical personality culture. Basics of a healthy lifestyle student.
2. Fundamentals of self-study methods and self-control over the state of your body.
3. Features of the use of physical culture to optimize performance.
4. General physical and special training in the system of physical education.
5. Sport. Individual choice of sports or exercise systems. Professional and applied physical training of students.
6. Physical culture in the general cultural and vocational training of students. Its socio-biological basis. Legislation on physical culture and sport.
7. Athletics. Long jump from the spot. Running exercises. Running for short, medium and long distances. Throwing grenades. Relay race
8. Athletic gymnastics. Exercises with the use of gymnastic equipment and simulators.
9. Table Tennis. Submission, reception. Training game.
10. Volleyball. Transfer and receive the ball from the top, bottom. Top ball, bottom ball. Training game.
11. Basketball. Transfer and catch the ball on the spot, in motion; throw in the basket. Training game.
12. Football. Transfer, stop and dribble, hitting the ball, juggling the ball. Training game.
13. Skiing. Movement by a free wheeling on average and long distances.
14. Outdoor games. Sports games according to simplified rules, adapted to the existing equipment and sports equipment.
15. Checkers and chess. Training game.

PROFESSIONAL PRACTICE MODULE – 12 CREDITS

Common cultural competencies:

- search and use of information necessary for the effective implementation of professional tasks, professional and personal development; set a goal and choose ways to achieve it;
- work in a team and a team, communicate effectively with colleagues, management; take responsibility for the work of team members, the result of the assignments; be responsible for your own decisions and be prepared to provide a rationale for these decisions;

- demonstrate critical thinking when working with new information.

Professional competencies:

- understand the physical picture of the world, the basic physical processes responsible for the nature and observable features of space objects and phenomena;
- understand, state and critically analyze basic information in the field of mechanics, molecular physics, electromagnetism, optics, atomic physics, fundamentals of radiophysics and electronics;
- use the main electronic equipment and physical devices for measuring mechanical and electrical quantities;
- analyze the general characteristics, physical and chemical properties of astronomical objects;
- explain the patterns of formation, development, structure and movement of astronomical objects;
- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- determine the coordinates of celestial bodies and the time of astronomical events using calculations and using a moving map of the starry sky;
- work with astronomical catalogs and databases;
- to make special calculations of astronomical quantities;
- simulate physical processes occurring in outer space;
- demonstrate skills of mastering the methodological aspects of teaching physics and astronomy in general, individual topics and concepts;
- carry out the formulation, formulation and solve problems in physics and astronomy
- analyze the principles of processing information flows of astronomical data, use computer systems for collecting, processing and storing;
- use telescopes and receivers of cosmic electromagnetic radiation for scientific research;
- to organize and conduct special astronomical observations using modern astrophysical instruments and methods of observation;
- demonstrate skills of processing measurement results, plotting graphs and diagrams;
- to assess the results of professional research, the preparation of conclusions and proposals for their practical use;
- analyze the physical interpretation of new experimental information in the field of astronomy (astrophysics);
- use information and communication technologies in their professional activities;

- use modern databases and information extraction methods; to be guided in the conditions of change of technology in professional activity;
- work with specialized literature, use modern computing equipment and software for research work;
- acquire and use new knowledge and skills; participate in scientific discussions, write scientific articles.

As a result of studying the module, a student is able to:

- 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; 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; be able to identify and analyze natural and anthropogenic environmental processes and possible ways to regulate them;
- use information and communication technologies in their professional activities; be able to use the ethical standards of a professional in the field of political analysis and forecasting; search for information necessary for the effective performance of professional tasks;
- apply physical laws to the study of the structure, origin and evolution of astronomical objects and the universe as a whole;
- understand the physical picture of the world, the basic physical processes responsible for the nature and observable features of space objects and phenomena; understand, present and critically analyze the characteristics, physical and chemical properties, patterns of formation, development, structure and movement of the studied celestial bodies and their systems;
- independently formulate and solve problems in physics and astronomy, formulate algorithms for modeling processes occurring in outer space; to evaluate the results of research, the preparation of conclusions and proposals for their practical use;
- analyze the principles of processing information flows of data, be able to use computer systems for collecting, processing astrophysical data; analyze the physical interpretation of new experimental information in the field of astronomy (astrophysics);
- use the main electronic equipment and physical devices for measuring mechanical and electrical quantities; understand the physical principles of operation of modern receivers of cosmic electromagnetic radiation, the construction of telescopes used in all ranges of the electromagnetic spectrum;

- characterize the hardware and software parts of providing astronomical observations, basic physical processes and features of the interaction of the radiation of astronomical objects with the environment;
 - demonstrate skills of the mathematical apparatus and formalisms in modern theoretical astrophysics, the criteria for choosing methods for solving problems both in analytical form and using computer technologies (modern computers and corresponding software products);
 - demonstrate skills of mastering the methodological aspects of teaching physics and astronomy in general, individual topics and concepts; methods and techniques for drawing up tasks, exercises, tests on various topics;
 - use 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; to the perception, analysis, synthesis of information, setting goals and choosing ways to achieve it;
 - understand socio-ethical values based on social and legal norms and tolerance to various cultural and confessional traditions; systematize conceptual knowledge of the legal framework for countering corruption and be aware of its role in the context of professional activities.
- Methods for evaluating the results achieved:
- oral survey: interview, report protection;
 - written work: test;
 - innovative assessment tools: discussion, project method, method of successive situations, etc.

Educational practice - 4 credits

Prerequisites: Basic and major disciplines.

Post requisites: PrP Production Practice, PdP Undergraduate Practice.

As a result of the practice, the student is able to:

- Consolidate, expand and deepen the theoretical knowledge in the development of the chosen topic;
- to learn, acquire new knowledge, skills and abilities during the self-directed work on the topic;

- to conduct written and oral communication in Russian (Kazakh, English) in the framework of professional and scientific communication, both interpersonal and group; analyze, write and edit academic and technical texts in Russian (Kazakh, English) to solve the problems of professional and scientific activities in the field of physics and astronomy;
- work with astronomical databases of scientific articles ADS.

Understand the purpose and basic principles of scientific and technical devices and equipment;

- Collect, systematize scientific information;

Determine the structure of the scientific report;

- Prepare a brief report on the completed work in the Latex format;
- Present the results of educational practice in the form of a presentation and be able to make a clear and clear presentation of the material;

Content of practice:

1. Acquaintance with research directions and themes;
2. Acquaintance with the research achievements of the selected scientific group. Choice the supervisor and research topic.
3. Educational and scientific work under the guidance of the supervisor: the study of theoretical and experimental research methods; research, study and analysis of the literature on the task;
4. Attend scientific seminar and follow-up report;
5. Preparation of reporting documentation on the results of educational practice.

Work practice - 8 credits

Prerequisites: Basic and major disciplines, UP Training practice.

Post requisites: PdP Pre-diploma practice.

As a result of the practice, the student is able to:

- acquire initial practical skills in solving specific problems in professional activities;
- work with information: find, evaluate and use information from various sources necessary for solving scientific and professional problems (including on the basis of a systematic approach);
- critically evaluate and rethink the accumulated experience (own and someone else's);
- analyze the method of setting and conducting an experiment; describe problems and situations of professional activity;
- show creativity, initiative and perseverance in achieving goals (both professional and personal);
- acquire the skills and abilities of conducting research, solving specific scientific, methodological, information retrieval tasks;
- plan the experiment and draw up observation programs using the GILDAS software package: ASTRO
- to conduct observations on scientific research equipment and telescopes.
- master the skills of management, operation and collibration of scientific equipment.
- make measurements and measurements. Evaluate experimental errors and instrumental and statistical errors.
- perform the initial reduction of the “raw” material for the purpose of subsequent analysis using the software packages IRAF, AIPS, CLASS.
- analysis, processing and obtaining a scientific result in software environments MATLAB, GREG, DS9.
- work with identical data from other observations from astronomical databases of similar projects.

Comparison of the results obtained with the data of other authors and interstate the standard result.

- Draw conclusions about the physical nature of the observed object and processes.
- Prepare a publication for discussion at an international conference of young scientists.
- competently and reasonably publicly present the results of their scientific and professional activities, including using modern ICT tools;
- participate in research projects.

Content of practice:

1. Faculty Orientation Conference. Issuing assignments and instructions on practical training and safety rules.
2. Acquaintance with the structure and nature of the selected unit; familiarization with the main research directions and themes of the scientific group and supervisor;
3. Formation of an individual student work plan during work experience.
4. Fulfillment of research tasks.
5. Final reporting conference. Presentation of the report on the research work at a scientific seminar.

Pre-diploma internship – 2 credits

Prerequisites: core and major disciplines, UP Educational internship, PrP Industrial internship, PrP Industrial internship.

Postrequisites: NZDR Writing and defense of the thesis (project).

As a result of the practice, a student is able to:

- apply the acquired knowledge in practical activities to solve specific scientific, methodological, information retrieval tasks;
- work with information: find, evaluate and use information from various sources (catalogs, databases) necessary to solve scientific and professional problems (including on the basis of a systematic approach);
- form the skills and abilities of conducting fundamental and applied scientific research in the field of physics and astronomy;
- professionally compile and execute scientific and technical documentation, scientific reports, present the results of research work, taking into account the specifics of the study;
- competently and reasonably publicly present the results of their scientific and professional activities, including using modern ICT tools.

Content of internship:

1. Installation conference. Issuing assignments and briefing on practical training.
2. Acquaintance with the base of pre-diploma practice. Formation of the individual work plan of the student during the pre-diploma practice.
3. Search and study of modern literature to justify the research topic.
4. Drawing up a work plan and schedule for the implementation of scientific research on the topic of the thesis.

5. Methodological substantiation of the research (setting goals for specific tasks, formulating a working hypothesis, generalizing and critically analyzing the works of domestic and foreign experts on the research topic);
6. Compilation of bibliography on the topic of research work by standard;
7. Description of the object and subject of study.
8. Collection and analysis of available information about the subject of the study.
9. The study of certain aspects of the problem. Researching.
10. Statistical and mathematical processing of information.
11. Analysis of the results of scientific research.
12. Registration of the results of the study and their coordination with the supervisor.
13. Generalization of the collected material.
14. Registration and protection of a practice report at a scientific seminar.
15. Final reporting conference.

CATALOG OF DISCIPLINES

GENERAL EDUCATION DISCIPLINES (GED)			
OBLIGATORY COMPONENT (OC)			
Social and humanitarian module – 6 credits			
Code SIK1101	Modern history of Kazakhstan (<i>State exam</i>)		
Prerequisites	no	Postrequisites	no
Credits	3	Term	1
Aim of the discipline	To form a system of scientific views on the history of modern Kazakhstan society in the context of the world historical process.		
Abstract of the discipline	Discipline "Modern history of Kazakhstan" is aimed at shaping future thinking specialists, focused on self-development with the priority of universal values. Large-scale transformations are accompanied by the modernization of public consciousness, which involves the transformation of learning based on a problem-based approach. Knowledge gained from the study of modern history of Kazakhstan contributes to the understanding of the dynamics of the development of the historical process and forms value reference points for ethnic, social, cultural identity in the surrounding world. Successful implementation of the state programs “Madeni Mura” and “Halyk Tarikh Tolknynda” expanded the horizons of historical knowledge and led to fundamental work aimed at changing the public consciousness and forming a united Nation of strong and responsible people . Present stage of development of our country is characterized by the Third Modernization of Kazakhstan, creation of a new model of economic growth that will ensure the global competitiveness of the country. Modernization of the economy is inextricably linked with the modernization of consciousness, when every citizen of Kazakhstan must understand the need for change in order to move to a qualitatively new level of development of his country. Kazakhstan society should have a spiritual and ideological core for the successful implementation of the goals set, this is facilitated by the program “Ruhani zhagyr” which reveals the mechanisms of modernization of public consciousness and is based on the continuity of spiritual and cultural traditions. Knowledge of the history of their people contributes to a broader perception and ability to rethink.		
Code Fil2102	Philosophy		

Prerequisites	SIK1101 Modern history of Kazakhstan.	Postrequisites	no
Credits	3	Term	4
Aim of the discipline	Formation of students' holistic system understanding of philosophy as a special form of knowledge of the world, its main sections, problems and methods of their study in the context of future professional activity.		
Abstract of the discipline	Discipline “Philosophy” is aimed to develop students' openness of consciousness, understanding self national code and national self-awareness, spiritual modernization, competitiveness, realism and pragmatism, independent critical thinking, cult of knowledge and education, and mastering such key ideological concepts as justice, dignity and freedom, as well as the development and strengthening of the values of tolerance, intercultural dialogue and the culture of peace. Particular attention is paid to the problems of preserving national identity, the inner core of the national “I” and the national spirit, which are reflected in the project “Rukhani zhagyru”, role of philosophy in modernizing public consciousness and solving global problems of modernity. Moral self-regulation, contributes to the development of research abilities and the formation of intellectual and creative potential.		
Instrument module – 15 credits			
Code IYa1103	Foreign language		
Prerequisites	no	Postrequisites	POIYa2207 Professionally-oriented foreign language.
Credits	6	Term	1, 2
Aim of the discipline	Increasing the initial level of proficiency in a foreign language, achieved at the previous level of education, and mastering students with the necessary and sufficient level of communicative competence to solve social and communicative tasks in various areas of everyday, cultural, professional and scientific activities.		
Abstract of the discipline	The “Foreign Language” discipline is aimed at further developing the language competencies acquired at school as part of the English language discipline program (General English), as well as deepening skills in the use of English as a means of communication with the formation of the following competencies: communicative (reading, writing, listening, speaking), language (pronunciation, vocabulary, grammar), general cultural and interpersonal.		
Code K(R)Ya 1104	Kazakh (Russian) language		

Prerequisites	no	Postrequisites	POK(R)Ya2206 Professionally-oriented Kazakh (Russian) language, KRYaK2108 Culture of speech and language communication.
Credits	6	Term	1, 2
Aim of the discipline	Provide high-quality Russian language proficiency in the context of Kazakh national culture as an instrument of social, intercultural, professional and personal communication through the formation of communicative competence in all types of speech activity in accordance with the levels of proficiency in a foreign language on a scale of the Council of Europe (A1, A2 + LSP; B1, B2+ LSP; C1 + LSP).		
Abstract of the discipline	Discipline "Kazakh (Russian) language" is aimed to forming the social and humanitarian outlook of students in the context of a nationwide idea of spiritual modernization, involving the development of internationalism, tolerant attitude to world cultures and languages as the basis of national consciousness and cultural code. modern technologies, the use and transfer of which can ensure the modernization of the country and the personal career growth of future specialists.		
Code IKT1105	Information and communication technologies		
Prerequisites	no	Postrequisites	KMFPS3210 Computer modeling of physical processes, IEAAS4308 Information –entropy Analysis of Astrophysical Signals, TsKS3309 Digital space communications
Credits	3	Term	2
Aim of the discipline	Formation of the ability to critically assess and analyze processes, methods of searching, storing and processing information, methods of collecting and transmitting information through digital technologies.		
Abstract of the discipline	Discipline "Information and communication technologies" is designed to build the ability to critically understand the role and importance of modern information and communication technologies in the era of digital globalization. In connection with the entry of the economy of Kazakhstan into the era of the Fourth Industrial Revolution, the adoption of a comprehensive program “Digital Kazakhstan”, the development of		

	new technologies such as the Internet of Things, cloud technologies, big data, blockchain, etc. thinking, the acquisition of knowledge and skills in the use of modern information and communication technologies in various activities.		
ELECTIVE COMPONENT (EC)			
Module of socio-political knowledge – 4 credits			
Code TPP2110	Theoretical and Applied Political Science		
Prerequisites	SIK1101 – Modern history of Kazakhstan.	Postrequisites	no
Credits	2	Term	3
Aim of the discipline	Studying the patterns of formation and functioning of politics, preparing students for participation in the political life of the country, the formation of an active citizenship.		
Abstract of the discipline	The discipline "Theoretical and Applied Political Science" forms knowledge about the laws of world politics and modern political processes, explaining the essence and content of the policies of nation states, based on ensuring national security and realizing national interests. The study of this discipline contributes to the formation of the socio-humanitarian outlook as the basis for the modernization of public consciousness. Understanding of internal and external relations and relations, major trends and patterns operating in different political systems, objective criteria of the social policy dimension contributes to the formation of national and civic identity.		
Code OPS2111	General and applied Sociology		
Prerequisites	SIK1101 – Modern history of Kazakhstan.	Postrequisites	no
Credits	2	Term	3
Aim of the discipline	Formation of sociological thinking and imagination of the dynamic social world in which we live, as well as in the formation of critical thinking and analysis of modern societies, their social structures, systems and institutions.		
Abstract of the discipline	The discipline "General and Applied Sociology" will allow a deeper insight into the fundamentals of sociology, including topics and applied aspects of research, theory and methodology. By developing what S. Wright Mills calls “sociological imagination,” the discipline will provide insights into how culture,		

	religion, history, people and institutions intersect in shaping their own experience, life chances and identity. Throughout the course, a number of macro- and micro-sociological “perspectives” will be presented and issues related to social inequality and accessibility of education, ethnicity, gender, social class, as well as institutions such as family, education, and the media, which play an important role in shaping our own life and the whole social world in which we live. Based on the Programmatic Article of the Head of State "Looking into the Future: Modernization of Public Consciousness", the course examines the peculiarities of the process of modernizing consciousness and adapting Kazakh society to the global challenges of our time.		
Module of cultural heritage and interpersonal communication – 4 credits			
Code KRYaK2108	Culture of speech and language communication		
Prerequisites	SIK1101 Modern history of Kazakhstan, OPS2111 General and applied Sociology, TPP2110 Theoretical and Applied Political Science, K(R)Ya 1104 Kazakh (Russian) language.	Postrequisites	POK(R)Ya2206 Professionally-oriented foreign language
Credits	2	Term	3
Aim of the discipline	Develop and improve the skills and techniques of effective speech interaction in various situations of communication, in the sociocultural and professional fields of communication.		
Abstract of the discipline	The course is aimed at improving the level of speech, communicative competence. The focus is on the culture of oral (monologue and dialogical) and written speech in the Kazakh (Russian) language. Attention is paid to the conditions for successful public speaking and effective communication skills are being formed in various conditions of communication. Students have the opportunity to improve their knowledge of the norms of the modern Kazakh (Russian) language. When studying the discipline, the following aspects will be considered: the concept of "culture of speech"; speech culture of a business person; main aspects of business culture; regulatory aspect of business culture; types of language norms of the Russian literary language; the communicative aspect of business culture; communicative qualities of speech (pithiness of speech, accuracy, clarity, purity, richness and diversity of speech); ethical aspect of culture of speech; functions of speech etiquette in business communication;		

	communication atmosphere and etiquette formulas; system of addresses in Russian speech etiquette; the role of ethics in business communication; business rhetoric; knowledge of the art of public speaking, the necessary modern business person; principles of culture of oratory; requirements for public speech; target settings of speech and their classification; speech design; creation of speech text; argumentation in oratorical speech; classification of speech types; information speech; persuasive speech; a call to action; main characteristics of business communication; principles of effective business communication; culture of oral business communication; types of oral business communication; presentation; modeling of oral business communication situations: “Telephone conversation”, “Business conversation”, “Negotiations”; culture of written business speech; types of business documents; features of drawing up personal business documents (application, power of attorney, receipt, autobiography, resume); features of the preparation of information and reference documents (explanatory note, protocol, extract from the protocol); features of writing business letters.		
Code PMK2109	Psychology of interpersonal communication		
Prerequisites	SIK1101 Modern history of Kazakhstan, Fil2102 Philosophy	Postrequisites	no
Credits	2	Term	3
Aim of the discipline	To form students' social-personal and instrumental competences in the field of psychological theory and practice of interpersonal communication, necessary in professional activities.		

Abstract of the discipline	The discipline "Psychology of interpersonal communication" contributes to the formation of a general psychological culture of a person, awareness of his past, present and future from psychological positions, as well as for mastering knowledge of the socio-psychological patterns of behavior in interpersonal communication. When studying the discipline, the following aspects will be considered: personality psychology and its role in the system of human sciences; motivational-need sphere of personality; emotions and emotional intelligence; volitional processes and the psychology of self-regulation; temperament and character; values, interests, norms as the spiritual basis of personality; psychology of the meaning of life and professional self-determination; career psychology; psychology of communication; perceptual side of communication; interactive side of communication; the communicative side of communication; the concept and structure of the socio-psychological conflict; personality behavior patterns in conflict; techniques and techniques of effective communication.		
CORE DISCIPLINES (CD)			
OBLIGATORY COMPONENT (OC)			
Module «General physics 1 and higher mathematics» – 10 credits			
Code Mech1201	Mechanics and molecular physics. Part 1. Mechanics (EEEE)		
Prerequisites	no	Postrequisites	MF1214 Mechanics and molecular physics. Part 2. Molecular Physics (EEEE).
Credits	3	Term	1
Aim of the discipline	To form among students an integral systemic view of the basic concepts and laws of mechanics and the methods of studying movement and interaction of material bodies and their systems arising from these laws.		
Abstract of the discipline	Discipline is aimed at developing a student's system of knowledge and skills, which allows explaining and analyzing the behavior of various mechanical systems under the influence of various forces. When studying the discipline, the following aspects will be considered: the kinematics of the material point, speed, normal acceleration and tangential; kinematics of circular motion; solid kinematics; the dynamics of the material point, Newton's laws; the dynamics of the system of material points; classification of forces		

	and interactions; gravitational force, mass inert and gravitational; inertial reference systems, Galilean relativity principle; non-inertial reference systems, inertial forces; work, potential field of forces, conservative forces; energy: potential energy; kinetic energy, energy conservation law; solid body dynamics; mechanics of liquids and gases; fluctuations; waves.		
Code EM2202	Electricity and magnetism, Optics. Part 1. Electricity and magnetism		
Prerequisites	MF1201 Mechanics and molecular physics. Part 1. Mechanics, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics.	Postrequisites	ED3225 Electrodynamics, FOE 3209 Physical bases of electronics, PEA4305 Semiconductor electronics in astrophysics;
Credits	4	Term	3
Aim of the discipline	Formation of a student's ideas about electromagnetism as a theory of electromagnetic phenomena, arising from the generalization of observations, practical experience and experiment, the basic concepts and laws of electromagnetism and the limits of their applicability.		
Abstract of the discipline	Discipline is aimed at the formation of a student's system of knowledge and skills, allowing to explain and analyze various electromagnetic phenomena. In studying the discipline the following aspects will be considered: electric charge, Coulomb's law, electric field in vacuum; Gauss electrostatic theorem; electric field potential; electrostatic field in and around conductors; electric capacity, capacitors, electric field energy; electrostatic field in dielectrics and near them; the concept of current, Ohm and Joule-Lenz laws; methods for calculating DC electrical circuits; electrical conductivity of semiconductors; electric current in liquids and gases; magnetic field in vacuum; magnetic field in matter; electromagnetic induction; Maxwell's system of equations; elements of AC circuits.		
Code MA1205	Mathematical analysis		
Prerequisites	no	Postrequisites	AGLA1211 Analytical geometry and linear algebra
Credits	3	Term	1
Aim of the discipline	Formulate in students a system of knowledge and skills that allows them to understand and use the differential and integral calculus of functions of one or several variables for solving physical problems.		

Abstract of the discipline	Discipline is aimed at teaching students the use of differential and integral calculus in solving problems of their specialty. When studying the discipline, the following aspects will be considered: the subject of mathematical analysis; elements of set theory; sequences of real numbers; limit of numeric sequence; the limit of a real function of a single real variable; the continuity of a function at a point and on a set; differentiability and derivative of the real function of one real variable; indefinite integral of function of one variable; certain integral; metric space; differentiability, partial derivatives and differentials of functions of several variables; multiple, curvilinear, and surface integrals; number series; functional sequences and rows; Fourier series.		
Module «innovative teaching methods and digital technologies» – 6 credits			
Code TMOFA3204	Theory and methods of teaching physics and astronomy		
Prerequisites	MF1201 Mechanics and molecular physics. Part 1. Mechanics, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics, EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism, Opt2215 Electricity and magnetism, Optics. Part 2. Optics.	Postrequisites	PrP Industrial internship
Credits	3	Term	6
Aim of the discipline	Formation of students' system of knowledge and skills necessary for teaching physics and astronomy in secondary schools using modern educational technologies.		
Abstract of the discipline	Discipline is aimed at developing students' knowledge about the content and organization of the educational process in physics and astronomy in institutions of secondary general (complete) education; preparation of specialists for teaching physics and astronomy in the modern school. When studying the discipline, the following aspects will be considered: the scientific-theoretical and methodological foundations of teaching physics and astronomy; theory and methods of teaching physics, subject of the discipline, goals and objectives; types of organization of studies in physics and astronomy in secondary schools; organization of studies in physics and astronomy in higher education; methods of		

	studying the main topics of the course in physics and astronomy; Mechanics; a system of methods and tools for teaching physics and astronomy; didactic principles of teaching physics; physics teaching methods; methods of intensification of teaching physics; types of physics lessons; types of educational physical experiment; control and evaluation of knowledge and skills; planning study classes in physics; calendar plan; lesson plan; methodological issues of the course of molecular physics; computer use in the study of physics.		
Code ORE4203	Fundamentals of Radio Physics and Electronics		
Prerequisites	EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism.	Prerequisites	EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism.
Credits	3	Credits	3
Aim of the discipline	To form the students' fundamental knowledge in the field of radiophysics and electronics, the development of skills in the use of electronic equipment.		
Abstract of the discipline	Discipline is aimed at developing students' systems of knowledge and skills that allow them to understand the principle of work and use general-purpose radio equipment in their professional activities. When studying the discipline, the following aspects will be considered: signals, their classification, parameters; elements of linear electric circuits, source of EMF, source of current; calculation of linear chains by the method of complex images; the passage of pulsed signals through linear circuits, transients, operator method of analysis; differentiating, integrating circuits, compensated voltage divider; electron-hole transition, its properties, semiconductor diodes, zener diodes, tunnel diodes; bipolar transistors, switching circuit; bipolar transistor as a quadrupole, parameters, equivalent circuits in different wiring diagrams; dynamic mode of the bipolar transistor; field effect transistors; classification of electronic amplifiers, their main characteristics, parameters; gain amplifier with feedback, negative and positive feedback; operational amplifiers, main characteristics, parameters; electrical signal generators; multivibrator in self-oscillatory mode.		
Module «professional language» – 4 credits			
Code POK(R)Ya2206	Professionally-oriented Kazakh (Russian) language		
Prerequisites	K(R)Ya1104 Kazakh (Russian) language	Postrequisites	Core and major disciplines

Credits	2	Term	3
Aim of the discipline	Formation of professionally-oriented linguistic personality, able to build communication in professionally significant situations.		
Abstract of the discipline	The discipline "Professional Kazakh (Russian) language" is aimed at the formation of practical skills of professional communication in the Kazakh (Russian) language and is intended to create a student's language readiness for further mastering special disciplines. When studying the discipline, the following aspects will be considered: professional vocabulary; term system of professional language; requirements for terms; business documentation in the professional field; business relations in the professional field; dialogue; monologue; scientific and journalistic style of speech; grammatical style features of a professional text; thesis; types of arguments; types of evidence: direct, indirect, theoretical and empirical; ways of presenting the material: historical, analogy, stepped, conceptual; work with sources; annotation; referencing; development of skills and readings of scientific literature in the specialty for the formation of professional competence; formulation of abstracts of a scientific article on the specialty; compiling a glossary; work on writing a scientific article on the specialty; increasing the level of speech, communicative competence in the professional sphere; the development of creative writing skills on the basis of secondary scientific texts, as well as texts relating to various functional-semantic types of speech; selection of material on the topic and problem of scientific research; rules for compiling bibliography; the semantic structure of the scientific text, its various types and skills of analyzing scientific information on the basis of generalization and compression.		
Code POIYa2207	Professionally-oriented foreign language		
Prerequisites	IYa1103 Foreign language	Postrequisites	Core and major disciplines
Credits	2	Term	4
Aim of the discipline	Teach students to use a foreign language as a means of expanding and deepening system knowledge in their field and a means of self-improvement of their professional qualifications.		
Abstract of the discipline	The discipline "Professionally-oriented foreign language" is aimed at teaching students basic grammatical rules, expanding vocabulary, developing listening skills for fluency in oral, written speech and learning professional terminology in their specialty. Levels: Pre-Intermediate, Intermediate, Upper-Intermediate.		

	When studying the discipline, the following aspects will be considered: professional vocabulary; term system of professional language; business documentation in the professional field; business relations in the professional field; dialogue; monologue; scientific and journalistic style of speech; grammatical style features of a professional text; thesis; types of arguments; types of evidence: direct, indirect, theoretical and empirical; work with sources; annotation; referencing; development of skills and readings of scientific literature in the specialty for the formation of professional competence; formulation of abstracts of a scientific article on the specialty; compiling a glossary; work on writing a scientific article on the specialty; increasing the level of speech, communicative competence in the professional sphere; the development of creative writing skills on the basis of secondary scientific texts, as well as texts relating to various functional-semantic types of speech; selection of material on the topic and problem of scientific research; rules for compiling bibliography; semantic structure of the scientific text, its various types; analysis of scientific information on the basis of generalization and compression.		
ELECTIVE COMPONENT (EC)			
Stem - module – 7 credits			
Code FOE3209	Physical bases of electronics		
Prerequisites	EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism.	Postrequisites	PrP Industrial internship
Credits	2	Term	6
Aim of the discipline	Formation of the student's understanding of the relationship between the physical laws of electronic processes in solids with the final characteristics of electronic devices.		
Abstract of the discipline	Discipline is aimed at shaping students' understanding of which physical processes and laws underlie the work of various electronic devices. When studying the discipline, the following aspects will be considered: the role of physical phenomena and processes in electronics, the main directions of development of electronics; elements of the band theory of the structure of solids, the filling of zones with electrons and the division of bodies into metals, dielectrics and semiconductors; statistical laws on particle collectives, Maxwell-Boltzmann distribution, Fermi-Dirac;		

	electron statistics in metals, statistics of charge carriers in a semiconductor; the law of the masses; conductivity, mobility of charge carriers, its dependence on temperature; mechanisms of scattering of free charge carriers; temperature dependence of conductivity in semiconductor and metal; diffusion current in semiconductors, total current in a semiconductor; equilibrium and nonequilibrium charge carriers; fundamentals of semiconductor physics; physical fundamentals of integrated electronics; diodes; thyristors; photoelectric devices based on external photoelectric effect; photoelectric devices based on the internal photoelectric effect.		
Code KMFPS3210	Computer modeling of physical processes		
Prerequisites	MF1201 Mechanics and molecular physics. Part 1. Electricity and magnetism, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics, EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism, Opt2215 Electricity and magnetism, Optics. Part 2. Optics.	Postrequisites	PrP Industrial internship
Credits	2	Term	5
Aim of the discipline	Formation of students' understanding of the principles of numerical modeling of physical phenomena, mastering the technique of setting a computer experiment in the field of physics.		
Abstract of the discipline	Discipline is aimed at developing students' skills in building models of physical processes and phenomena using personal computers, skills in developing algorithms that simulate physical phenomena and processing physical experiments, mastering techniques for implementing algorithms using high-level programming languages When studying the discipline, the following aspects will be considered: the goals, methods and approaches of modeling physical processes; a general description of high-level programming languages and modern integrated math packages (Matlab, Scilab, Maple, Mathematica, Mathcad); work with files; graphical presentation of calculation results; effective algorithms for the numerical solution of algebraic equations,		

	the division of complex numbers, the calculation of derivatives, the solution of systems of linear algebraic and differential equations; models of physical processes based on ordinary differential equations; models of physical processes based on partial differential equations; formal description of random processes; general scheme of Monte Carlo methods; modeling the movement of bodies in uniform force fields; modeling of oscillatory processes and wave movements; modeling the behavior of systems consisting of a large number of particles; simulation of phase transitions by the method of molecular dynamics; modeling of optical phenomena; simulation of quantum systems.		
Code AGLA1211	Analytical geometry and linear algebra		
Prerequisites	no	Postrequisites	OVT A2224 Fundamentals of vector-tensor analysis
Credits	2	Term	2
Aim of the discipline	Formation of students with the correct ideas about the basic concepts and methods of analytical geometry and linear algebra.		
Abstract of the discipline	Discipline is aimed at developing students' skills in solving problems of analytical geometry and linear algebra and using this skill in their professional activities. When studying the discipline, the following aspects will be considered: vector algebra: the concept of a vector, operations with vectors; straight line on the plane and in space; second order lines; second order surfaces; operations on matrices, their properties; determinant of the matrix, its properties and calculation; minors, algebraic complements, their properties; a system of n linear equations with n unknowns, methods for its solution; compatibility criterion, the Kronecker – Capelli theorem; linear space, sum and intersection of subspaces, direct sum of subspaces, properties; linear operators, their properties, examples; eigenvalues and eigenvectors of a linear operator; matrix of a linear operator, its transformation upon transition to a new basis; eigenvalues and eigenvectors of a linear operator; bilinear functions and quadratic forms in Euclidean space.		
Module «physics of stars» - 8 credits			
Code OA2212	Fundamentals of Astrophysics		

Prerequisites	OA1301 General Astronomy (EEEEA)	Postrequisites	SEZ4307 The Structure and Evolution of Stars
Credits	4	Term	4
Aim of the discipline	Formation of students' holistic understanding of the origin, structure, chemical composition, physical properties and evolution of various celestial bodies and their systems, as well as methods for obtaining this information.		
Abstract of the discipline	The discipline is aimed at a consistent presentation of the fundamentals of astrophysics, such as the methods used in research of objects of the Universe, the mechanisms of formation and passage through various environments of electromagnetic radiation, principles of operation and features of the use of modern astrophysical tools, observational manifestations of astrophysical objects, modern ideas about the structure, physical properties and evolution various objects of the universe. When studying the discipline, the following aspects will be considered: the tasks and main sections of astrophysics, space-time scales in astrophysics; basic photometric concepts and units; the mechanism of absorption and emission of light by a substance (atoms, molecules), the formation of continuous, emission and absorption spectra, the Zeeman effect, the Stark effect; radiation properties and the fundamentals of spectral analysis, Doppler shift of spectral lines; black body radiation; features and physical limitations of astronomical observations, the main tasks of observational astronomy, telescopes and radiation detectors; types of temperature, methods of its determination, determination of the chemical composition and density of celestial bodies; interstellar medium, its main components and observational manifestations; star classifications, Hertzsprung-Russell diagram, mass-luminosity ratio, stellar spectroscopy as a tool for determining fundamental stellar parameters; double stars, determination of the parameters of stars from observations of double stars; the internal structure of stars, their evolution; modern ideas about the internal structure and structure of the atmosphere of the Sun; non-stationary stars, ideas about the nature of their variability and research methods; hot stars with spectral features, Ae / Be Herbig, Be and B types [e]; compact stars as a result of the final stage of the evolution of stars.		
Code GA3213	Galactic astronomy		
Prerequisites	OA1301 General Astronomy (EEEEA)	Postrequisites	DZS4308 Dynamics of stellar systems

Credits	4	Term	5
Aim of the discipline	Formation of knowledge about the kinematics of stars in our galaxy, the composition and structure of subsystems of galaxies, obtaining basic information about the composition and structure of the galaxy.		
Abstract of the discipline	Discipline is aimed at developing students' knowledge about the structure and development of galaxies based on the study of the collective properties of stellar and gas objects in our and other galaxies. When studying the discipline, the following aspects will be considered: the coordinates of stellar astronomy; geometric methods for determining distances to celestial bodies; photometric methods for determining distances to celestial bodies; elements of the theory of potential and celestial mechanics, potential energy and the virial theorem; problems associated with the description of movements in the gravitational fields of the simplest configuration; tasks associated with the statistical processing of observations; numerical methods for studying the dynamic evolution of gravitating systems; composition and structure of spiral galaxies; full and selective absorption of light in the Galaxy; determination of excess color in the UBV system; the model of the visible distribution of the absorbing substance absorbing the substance in our Galaxy; general characteristics of scattered star clusters; determination of excess color, distance and age of the scattered clusters; GR-diagram of the scattered cluster; stellar associations, complexes and mobile groups; submerged clusters; gas hazardous disk; spiral branches and star formation.		
Module «general physics 2» - 9 credits			
Code MF1214	Mechanics and molecular physics. Part 2. Molecular Physics (EEEA)		
Prerequisites	Mech1201 Mechanics and molecular physics. Par 1. Mechanicst.	Postrequisites	FKS 3218 Condensed state physics
Credits	3	Term	2
Aim of the discipline	Acquaintance with the fundamentals of the molecular-kinetic theory of the motion of liquids and gas, the basic models of molecular physics, the statistical laws of a system of a large number of particles, models and laws of ideal and real gases, the classical distribution of molecules, the basics of the classical theory of heat capacity and quantum theory, the phenomena of thermodynamics and their fundamental nature, the properties of liquids, solids and phase transitions; development of skills: to assess the basic parameters of thermodynamic systems in various states - gaseous, liquid, solid; to determine the limits of applicability of		

	the classical distribution of particle velocities in the force field; to single out from the large volume of new complex information the main thing, to take notes, to work with literature and Internet resources.		
Abstract of the discipline	Discipline is aimed at shaping students' understanding of the main phenomena, concepts, laws and methods of molecular physics and thermodynamics, as well as the skills of practical calculations and experimental work. When studying the discipline, the following aspects will be considered: molecular kinetic theory; perfect gas; the concept of temperature; velocity distribution of gas molecules; the first law of thermodynamics; the second law of thermodynamics; real gases and liquids; transfer phenomena; surface phenomena in liquids; solids; waves in continuous medium and acoustic elements; waves in elastic media; phase and group velocity; wave propagation in inhomogeneous media; reflection and refraction of waves at the boundary of two media.		
Code Opt2215	Electricity and magnetism, Optics. Part 2. Optics		
Prerequisites	EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism	Postrequisites	AF3216 Atomic physics
Credits	3	Term	4
Aim of the discipline	Acquisition of knowledge about various optical phenomena and approaches to their description; the formation of skills and competencies for their analysis, research and application of calculation methods in solving real problems in future professional activities.		
Abstract of the discipline	Discipline is aimed at shaping students' understanding of the laws of optics in their relationship with the entire spectrum of laws of physics and the limits of their applicability; skills of using basic optical devices, analyzing the experimental data obtained and using them to calculate the characteristics of optical systems. When studying the discipline, the following aspects will be considered: electromagnetic waves; photometry; geometrical optics; light interference; light diffraction; basics of holography; optics of inhomogeneous media; polarization; light dispersion; light absorption; optics of anisotropic media; light scattering; fundamentals of quantum optics; nonlinear optics; power optics.		
Code AF3216	Atomic physics		

Prerequisites	MF1201 Mechanics and molecular physics. Part 1. Electricity and magnetism, MF1214 Mechanics and molecular physics. Part 2. Molecular Physics, EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism, Opt2215 Electricity and magnetism, Optics. Part 2. Optics.	Postrequisites	YaF3217 Nuclear physics
Credits	3	Term	5
Aim of the discipline	Formation of an integrated system of students knowledge of the basics of modern physics of atoms and atomic phenomena, the basic quantum concepts, the development of skills for constructing quantum-mechanical models and solving physical problems.		
Abstract of the discipline	Discipline is aimed at forming in future specialists a representation of a physical theory as a generalization of observation, practical experience and experiment, described at the appropriate mathematical level, as a link between physical phenomena and quantities. When studying the discipline, the following aspects will be considered: the development of quantum concepts; corpuscular properties of light; Coordinate, momentum, angular momentum and energy operators in quantum mechanics; introduction to the apparatus of physics of micro-objects; stationary and nonstationary Schrödinger equation; energy states and emission spectra of hydrogen-like atoms; spectra of hydrogen-like atoms; electron orbital and spin moments; multielectron atoms; quantum statistics; quantum properties of a solid; bond types of atoms in solids; electrical conductivity of solids; elementary particles; Physics of the atomic nucleus.		
Module «general physics 3» - 8 credits			
Code YaF3217	Nuclear physics		
Prerequisites	MF1201 Mechanics and molecular physics. Part 1. Electricity and magnetism, MF1214 Mechanics and molecular	Postrequisites	PrP Industrial internship.

	physics. Part 2. Molecular Physics, EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism, Opt2215 Electricity and magnetism, Optics. Part 2. Optics, AF3216 Atomic physics.		
Credits	3	Term	6
Aim of the discipline	Formation of general cultural and general professional competencies in terms of sections of modern physics: the atomic nucleus and elementary particles; Acquaintance of students with the most important experimental facts underlying quantum concepts; Formation of students' understanding of the composition and properties of atomic nuclei, radioactive transformations, nuclear reactions, the main problems of nuclear energy, modern concepts of elementary particle physics.		
Abstract of the discipline	Discipline is aimed at clarifying the physical meaning and content of the basic laws and concepts of nuclear physics, establishing the limits of applicability of these laws, developing students' skills in physical thinking and the ability to set and solve specific problems. When studying the discipline, the following aspects will be considered: the place and importance of nuclear physics; static properties of atomic nuclei; radioactivity; laws of simple and complex radioactive decay; problems and prospects for the development of world and domestic energy, the role of atomic energy; thermonuclear reactions in the universe and in the laboratory; interaction of radiation with matter; interaction of heavy charged particles with matter; nuclear reactions; conservation laws in nuclear reactions; mechanisms and parameters of nuclear reactions; detectors of particles of ionizing radiation; registration of charged and neutral particles of various energies; elementary particles; particle and antiparticle models.		
Code FKS3218	Condensed state physics		
Prerequisites	MF1214 Mechanics and molecular physics. Part 2. Molecular Physics.	Postrequisites	PrP Industrial internship
Credits	3	Term	6

Aim of the discipline	Formation of a fundamental knowledge base of existing ideas in the field of condensed matter physics, based on modern scientific data.		
Abstract of the discipline	Discipline is aimed at developing students' understanding of the physical nature of the structure, mechanical, thermal, electrical and magnetic properties of solids. In studying the discipline, the following aspects will be considered: condensed state and the formation of a crystalline body; classification of a solid by structure and properties; concept of translational symmetry; crystallographic classes and systems; crystal interaction with electromagnetic waves; back grill; weak chemical bonds in solids; strong chemical bonds in solids; free electron gas in metals, electrical conductivity of metals, Hall effect, electronic heat capacity; Fermi gas of free electrons; free electron model; almost free electron model; zone theory in solids: classification by features of the energy spectrum of electrons in solids, energy zones and the Fermi surface, the electron effective mass tensor; oscillation of a diatomic chain and its solution; defects in solids.		
Module «workshop on general physics» - 7 credits			
Code PM1220	Workshop - mechanics		
Prerequisites	no	Postrequisites	PMF1221 Workshop- Molecular physics
Credits	2	Term	1
Aim of the discipline	To develop the ability to practice basic theoretical knowledge for laboratory work.		
Abstract of the discipline	Discipline is aimed at checking the theoretical foundations of mechanics, acquaintance with physical instruments, measurement methods and interpretation of measurement results. When studying the discipline, the following aspects will be considered: accurate weighing of bodies; some methods of measurement results; determining the volume of the body of a regular geometric shape; calculation of the resistance of conductors by geometric dimensions; determining the speed of a bullet with a ballistic pendulum; determination of the moment of inertia of the pebbler overbucker by the dynamic method; determination of the coefficient of internal friction of the fluid according to the Stokes method; verification of the laws of conservation of momentum and energy on the example of the collision of bodies; determination of the acceleration of free fall using a machine; Maxwell's pendulum; study of the movement		

	of the gyroscope; measuring the speed of a bullet; measurement of the speed of sound in air by the interference method; measuring the speed of sound in the air by the standing wave method; measurement of elastic moduli from stretching.		
Code PMF1221	Workshop – Molecular physics		
Prerequisites	PM1220 Workshop- mechanics	Postrequisites	PEM2222 Workshop- Electricity and magnetism, FKS3218 Condensed state physics.
Credits	2	Term	2
Aim of the discipline	Training in the ability to put into practice basic theoretical knowledge for laboratory work.		
Abstract of the discipline	Discipline is aimed at contributing to the formation of the students' scientific outlook by mastering the system of generalized knowledge about nature and the ways of its cognition; the ability to interpret experimental data presented in the form of graphs, diagrams, tables and other means of presenting scientific knowledge. When studying the discipline, the following aspects will be considered: determination of the ratio of specific heat capacities by the adiabatic method; determination of thermal conductivity coefficient of solid heat insulator; determination of the coefficient of internal friction of the liquid: according to the Stokes method, using a capillary viscometer; determination of the coefficient of internal friction of gases, the average free path length and the effective diameter of air molecules: using a gas meter, according to the average speed of a drip fluid flow determination of the coefficient of surface tension of a liquid: by the method of droplets, by the method of gas bubbles; determination of air humidity: using a condensation hygrometer with thermoelectric cooling, using an Assman aspiration psychrometer; acquaintance with statistical laws on mechanical models; determination of air thermal conductivity; phase transitions: determination of melting point; study of translational and rotational Brownian motion; study of the thermodynamics of sound vibrations; study of calorimetric vessel; determination of the specific heat of the liquid; determination of the heat capacity of a solid by the calorimetric method; Check Gauss distribution law.		
Code PEM2222	Workshop- Electricity and magnetism		

Prerequisites	PM1220 Workshop- mechanics, PMF1221 Workshop- Molecular physics	Postrequisites	PO2223 Workshop- Optics, ED3225 Electrodynamics
Credits	1	Term	3
Aim of the discipline	To impart practical skills in applying theoretical knowledge of electricity and magnetism to solve various physical problems of an applied nature and to conduct an experimental study of electrical phenomena.		
Abstract of the discipline	Discipline aims to deepen the theoretical and practical knowledge of the physical nature of electrical phenomena, the basic laws of the course of electromagnetic processes. When studying the discipline, the following aspects will be considered: interaction of point charges and particles; electrostatic field strength; potential and energy of an electrostatic field; electrostatic field in dielectrics; direct electric current; work and power current; electrical conductivity; electric current in vacuum and in gases; branched DC circuit; Kirchhoff's laws; a magnetic field; Lorentz force; the movement of charged particles in a magnetic field; Ampere power; conductor with current in a magnetic field; magnetic field energy; electromagnetic induction; electromagnetic oscillations and waves.		
Code PO2223	Workshop- Optics		
Prerequisites	PM1220 Workshop- mechanics, PMF1221 Workshop- Molecular physics, PEM2222 Workshop- Electricity and magnetism	Postrequisites	AF3216 Atomic physics
Credits	2	Term	4
Aim of the discipline	Formation of students' skills in the application of theoretical material to the analysis of specific physical situations, experimental study of the basic laws.		
Abstract of the discipline	Discipline is aimed at developing students' practical skills with laboratory equipment, the ability to plan and carry out a laboratory experiment. When studying the discipline, the following aspects will be considered: the study of a microscope and the determination of the refractive index of glass using a microscope; studying the process of photographing; getting negative and positive; determination of the refractive index of liquid and solids using an Abbe refractometer, the calculation of the diameters of water molecules and glycerin; light interference; Newton's		

	rings; determination of the refractive index, dispersion and resolution of a prism using a goniometer spectrometer; diffraction on transparent and reflective gratings; Fraunhofer light diffraction study; diffraction of light in the near zone (Fresnel diffraction); determination of the refractometric characteristics of air using the Rayleigh interferometer; optical pyrometer; the study of the laws of thermal radiation; the study of the laws of light absorption; the study of the photoelectric effect; the study of the polarization of light; definition of Rydberg constant.		
Module «theoretical physics» - 6 credits			
Code OVTA2224	Fundamentals of vector-tensor analysis		
Prerequisites	AGLA1211 Analytical geometry and linear algebra	Postrequisites	ED3225 Electrodynamics
Credits	2	Term	4
Aim of the discipline	Provide the student with the necessary knowledge and inculcate practical skills in working with the fundamental concepts of vector and tensor analysis.		
Abstract of the discipline	Discipline is aimed at developing students' knowledge of the basic concepts of vector and tensor analysis, actions on tensors and tensor fields. When studying the discipline, the following aspects will be considered: elements of tensor algebra; vector algebra operations in tensor notation; elements of differential geometry; Formulas freinet; the first and second quadratic forms and their application; surface area; curvilinear coordinates in three-dimensional space; the expression of the elements of the arc length for the coordinate curves, the elements of the areas for the coordinate surfaces and the volume element in terms of the Lamé coefficients; scalar and vector fields; limit, continuity, differentiability of scalar and vector fields; curvilinear and surface integrals; curvilinear integrals of the first and second kinds and their applications; Green's formula; elements of field theory; Ostrogradsky-Gauss theorem in vector form.		
Code ED3225	Electrodynamics		
Prerequisites	EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism	Postrequisites	FOE3209 Physical bases of electronics
Credits	2	Term	5

Aim of the discipline	The development and deepening of the basic knowledge of students in the field of electromagnetism, laid in the study of various disciplines of general physics.		
Abstract of the discipline	Discipline is aimed at developing students' knowledge of the electromagnetic field. In studying the discipline the following aspects will be considered: the Maxwell equation in integral and differential forms; boundary conditions for tangential and normal field components in the general case; charge conservation law (continuity equation) in differential and integral forms; energy conservation law (Poynting theorem) in differential and integral forms; Maxwell's equation in complex form, complex dielectric constant; skin effect, skin layer thickness (depth of current and field penetration into the conductor); recording expressions for a plane wave in vector form and in projections on the axis of the Cartesian coordinate system; dispersion equation for a uniform plane wave; definition of phase and group velocity; Fresnel formulas in the case of a normal fall; general expression for the vector potential of a given distribution of arbitrary in time and harmonic currents; the expression for the vector potential of a given distribution of harmonic currents in the Fraunhofer zone; the field of an elementary electric dipole in the quasistatic zone; the field of an elementary electric dipole in the wave zone; radiation pattern.		
Code KM3226	Quantum Mechanics		
Prerequisites	OVT A2224 Fundamentals of vector-tensor analysis, Opt2215 Electricity and magnetism, Optics. Part 2. Optics.	Postrequisites	YaF3217 Nuclear physics
Credits	2	Term	6
Aim of the discipline	Teaching students how to use the mathematical apparatus of non-relativistic quantum mechanics, using approximate methods; show the features of the quantum description of particle motion in potential fields.		
Abstract of the discipline	Discipline is aimed at developing students' knowledge of the basic concepts and concepts of non-relativistic quantum mechanics. When studying the discipline, the following aspects will be considered: quantum concepts; the need for a probabilistic interpretation of the motion of a quantum particle; properties of eigenfunctions of operators; Schrödinger equation; change over time of the average values of the observed parameters; Ehrenfest theorems; a particle in a one-dimensional rectangular potential well; general properties of motion in a		

	centrally symmetric field; elements of the theory of representations; spin and wave function of a particle with spin; Schrödinger equation for a particle with spin; wave function of a particle system; Hamilton operator and Schrödinger equation for an atom; probability of quantum transitions; uncertainty and width of the level.		
MAJOR DISCIPLINES (MD)			
OBLIGATORY COMPONENT (OC)			
Module «general astronomy» - 5 credits			
Code OA1301	General Astronomy (EEEE)		
Prerequisites	no	Postrequisites	OA2212 Fundamentals of Astrophysics
Credits	3	Term	2
Aim of the discipline	Formation of the students' system of sequential, logically following each other knowledge about the subject of astronomy, about the methods and tools used by astronomers to study space objects and the Universe as a whole, about the main results of these studies.		
Abstract of the discipline	Discipline is aimed at the formation of students' general ideas about the location, movement, structure, origin and evolution of various celestial objects and their systems, as well as about the methods of their study. When studying the discipline, the following aspects will be considered: the subject of astronomy, its sections; basics of spherical astronomy, horizontal and equatorial coordinates; the movement of the sun on the celestial sphere, the ecliptic; basic time counting systems; visible movements of the planets on the celestial sphere, the main configuration of the planets; Kepler's laws, the main tasks of celestial mechanics; determining the size, shape of celestial bodies and distances to them; the movement of the Earth and the Moon, eclipses; electromagnetic radiation studied in astrophysics, its properties and the fundamentals of spectral analysis, the Doppler shift of spectral lines; basic concepts of astrophotometry; methods for determining temperature, determining the chemical composition and density of celestial bodies; astrophysical instruments and basic observation methods; nature and evolution of stars; our galaxy; fundamentals of extragalactic astronomy.		
Code Ast2302	Astrometry (EEEE)		

Prerequisites	OA1301 General Astronomy (EEEEA)	Postrequisites	DZS4308 Dynamics of stellar systems
Credits	2	Term	3
Aim of the discipline	Formation of students' holistic understanding of the theoretical foundations and practical methods of positional observations of celestial bodies, including from space, the acquisition of the skills necessary to reduce astrometric observations.		
Abstract of the discipline	Discipline is aimed at shaping students' understanding of modern methods of high-precision determination of the location of celestial bodies and their velocity vectors at a given point in time. When studying the discipline, the following aspects will be considered: the subject of astrometry, its main tasks, concepts and methods, new projects, connection with other areas of astronomy, its practical significance; systems of celestial coordinates and relationships between them; the figure of the Earth, the geoid equation, various systems of geographical coordinates; uneven rotation of the earth; terrestrial coordinate system; definition and implementation of coordinate systems in modern astrometry, epoch in astrometry; determining time using astrometric observations, the universal time system; world time systems; dynamic time scales; atomic time scales; the concept of astronomical refraction, refraction in a plane-parallel and spherically symmetric atmosphere; aberration; changing the coordinates of the stars under the influence of refraction and aberration; the deviation of the light beam in the gravitational field, the change in the coordinates of the reference source in the gravitational field of the sun; optical observation reduction procedure; review of instruments and methods of practical astronomy; radiointerferometry method with superlong bases in astrometry; cosmic astrometry.		
ELECTIVE COMPONENT (EC)			
Module «cosmology» - 9 credits			
Code SEV4303	Structure and evolution of the Universe		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	7

Aim of the discipline	To form among students a systematic idea of the modern models of the origin, development and structure of the Universe and large-scale structures in it, the theoretical and observational foundations of the study of these problems.		
Abstract of the discipline	Discipline is aimed at shaping students' understanding of modern models of the structure and evolution of the Universe, as constructed on the basis of the interpretation of numerous observational data from the point of view of fundamental physical laws. When studying the discipline, the following aspects will be considered: the observational foundations of the evolution models of the Universe: the structure in the Universe (star clusters, their properties; galaxies, their types, nuclei); structure in the Universe (clusters and superclusters of galaxies, large-scale structure of the Universe); relic radiation, its properties; observational bases of the models of the evolution of the Universe: chemical composition of the substance of the Universe, baryon asymmetry of the Universe; Hubble's law, the expansion of the universe, the acceleration of the expansion of the universe; hidden mass, hypotheses about its nature; dark energy, hypotheses about its nature; the concept of models of the Great Union, the possibility of mutual transformations of quarks and leptons from the standpoint of the models of the Great Union; Hot Universe Model: Hadron Era, Lepton Era; model of the hot universe: primary nucleosynthesis, the era of radiation, the era of matter; the difficulties of a hot universe model; inflationary stage of the Universe; anthropic principle, the multiplicity of worlds; the gravitational instability of Jeans and Livshits, the development of primary density perturbations; changes in the mass and length of Jeans with time, the formation of clusters of galaxies.		
Code OK4304	Fundamentals of Cosmology		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	7
Aim of the discipline	To form with students ideas about modern views on the properties and evolution of the Universe, which were formed as a result of the generalization of the observations of various phenomena in space and theoretical developments on the interpretation of these phenomena.		
Abstract of the discipline	Discipline is aimed at shaping students' perception of the Universe as a holistic self-developing and self-organizing system.		

	When studying the discipline, the following aspects will be considered: the finiteness and infinity of the Universe - the paradoxes of classical cosmology, the photometric paradox and the contradictions between the classical ideas about the structure of the Universe and observations; the need to involve the general theory of relativity to build a model of the universe; the relationship between the geometric properties of the space of the Universe with the distribution and movement of matter in it; expanding universe, the relationship of the average density of matter with the law of expansion and the geometric properties of the universe; determination of the radius and age of the universe; the abundance of helium in the universe and the need for its formation in the early stages of the evolution of the universe; the need for not only high density of matter, but also its high temperature in the early stages of the evolution of the Universe; Model "hot universe"; relic radiation; observation of supernovae in distant galaxies and the discovery of accelerated expansion of the Universe; Dark matter and dark energy, their contribution to the mass of the universe; anti-gravity instability of the cosmological substrate; evolution of perturbations of baryonic matter in the Universe; Search for life and mind in the universe, the development of ideas about the existence of life in the universe; Drake's formula and the number of civilizations in the galaxy.		
Code VA4305	Extragalactic astronomy - 3 credits		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	7
Aim of the discipline	Formation of the students' systemic understanding of the classification, structure, composition of various extragalactic objects and the physical processes in them.		
Abstract of the discipline	The discipline is designed to form students' knowledge of the classification, structure, composition and physics of galaxies of various types, their clusters and active nuclei. When studying the discipline, the following aspects will be considered: introduction, the subject of extragalactic astronomy, methods for determining distances to galaxies and their physical characteristics; spiral galaxies, their structure, types, stellar population; modern concepts of the spiral spiral arms of galaxies; elliptical galaxies, their types, structure and properties; lenticular galaxies; irregular galaxies of various types; the most characteristic representatives of different type of galaxies; the nature of cosmic radio sources; Seyfert galaxies, Lazertids, radio galaxies; signs and nature of activity of galactic nuclei; quasars;		

	a local group of galaxies, our closest neighbors; groups and clusters of galaxies; large-scale distribution of galaxies; evolution of galaxies		
Module «star astronomy» - 9 credits			
Code FPZ4306	Physics of variable stars		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	NOG3307 Nonstationary Objects of Galaxy
Credits	3	Term	7
Aim of the discipline	To form among students a systematic idea of the types and structure of variable stars, of the physics of phenomena leading to the variability of stars, and also of their research methods.		
Abstract of the discipline	The course is designed to form students' system of knowledge about the physical processes responsible for the variability of stars, as well as the types, composition and structure of variable stars. When studying the discipline, the following aspects will be considered: the concept of a variable star, the main groups of causes of stellar variability; main catalogs of variable stars; pulsating stars (general outline), the physical mechanism of stellar pulsations, the position of pulsating stars of different types on the Hertzsprung – Russell diagram; classical Cepheids, period – luminosity dependence; the Baade – Vesselink method for determining the physical characteristics of Cepheids and other radially pulsating stars, the period – age relationship; radial velocities of Cepheids, spectral double and eclipsed Cepheids, changes in Cepheid periods as a direct manifestation of stellar evolution; RR Lyrah variables, their role in studying the old population of the Galaxy; variables such as the Worlds of Whale, red semi-regular and irregular variable stars; type II cepheids in the galactic field and in globular clusters, their connection with stars outside the main sequences on the Hertzsprung – Russell diagrams of globular clusters; other types of pulsating variable stars: RV Taurus type stars, δ Shield, ZZ Ceutus, β Cepheus and others; explosive and new variable stars; new stars, physical mechanisms of outbreaks of classical and dwarf new ones; young eruptive variable stars: T-type stars Taurus, fuors, connection of the variability of young stars with accretion processes; stars with inhomogeneous surface brightness and variability due to axial rotation: variables of type BY Dragon, magnetic variables; variable stars are binary systems with compact components (black holes, neutron stars), their role for studying the processes of stellar evolution; introduction to eclipsing variable stars.		

Code SEZ4307	The Structure and Evolution of Stars		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	7
Aim of the discipline	To form in students a system of knowledge and skills necessary for understanding and analyzing the physical processes occurring in the depths and atmospheres of stars, about the ways of star evolution based on the physical laws governing these phenomena.		
Abstract of the discipline	Discipline is aimed at shaping students' understanding of the structure and physical processes in the depths and atmospheres of stars at different stages of their evolution. When studying the discipline, the following aspects will be considered: introduction: the role of stars in the Universe, the structure of stellar astrophysics, general characteristics of stars, an overview of methods for their determination; star as a physical object; physical classification of stars: normal stars, their main features; virial theorem for a star; basics of thermodynamics of stars, thermal stability of stars, negative heat capacity; virial theorem for a star; features of nuclear reactions in high and low mass stars, the role of radiation pressure in high mass stars, the Eddington limit of luminosity; system of stellar structure equations; star atmospheres, continuous spectrum of stars; the formation of spectral lines, emission lines in the spectra of stars; the basic principles of the theory of the evolution of stars, the dependence of radius-luminosity-mass, gravitational instability, the condition of fragmentation of a compressing cloud; stages of star formation, the effect of rotation and magnetic field on compression, protostars; advanced stages of the evolution of stars: the evolution of stars after the main sequence based on nuclear reactions, non-stationary processes in the later stages of the evolution of stars; the final stages of the evolution of stars: white dwarfs, degenerate gas and its pressure, limiting masses of white dwarfs; the final stages of the evolution of stars: supernova explosions, neutron stars, their limiting masses, basic concepts of black holes; the main types of physical variable stars, the causes of their variability.		
Code DZS4308	Dynamics of stellar systems		
Prerequisites	GA3213 Galactic astronomy	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	7

Aim of the discipline	Students form a holistic view of the dynamics of stellar systems as a section of astrophysics that studies the collective movement of a large number of stars under the influence of their general gravity, its problems and methods, developing an understanding of the theoretical foundations and methods of constructing and studying models of gravitating systems.		
Abstract of the discipline	Discipline is aimed at developing students' understanding of the theoretical foundations and methods for constructing and researching models of gravitating systems. When studying the discipline, the following aspects will be considered: the subject of stellar dynamics; morphological types of galaxies, features of their structure and population; potential theory: Poisson equation, potential energy tensor, spherical systems; potential of spheroidal and ellipsoidal systems, potential of disks; the problem of two bodies, the problem of three bodies; orbits in static spherical potentials, orbits in axisymmetric potentials, orbits in nonaxisymmetric potentials; Eulerian and Lagrangian approach to the description of fluid motion, phase space, particle distribution function in phase space, collisionless Boltzmann equation; Jeans equations, virial tensor equation, integrals of motion; disk dynamics and spiral structure; collisions and clashes, the Boltzmann equation in the presence of collisions; Fokker-Planck equation; relaxation mechanisms; evolution of spherical star systems: mass loss, evaporation and ejection, lifetime, nuclear collapse, tidal effect, the formation of binary stars and the collapse of the collapse; violation of star systems by high-speed collisions; galaxy formation: linear structure formation, non-linear structure formation; on origin of the large-scale structure of the universe.		
Module «physics of planetary systems» - 9 credits			
Code FP3309	Physics of Planets		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	SMIP3311 Spectral methods of Planets study
Credits	3	Term	5
Aim of the discipline	Formation of basic knowledge about the methods of studying the processes of the formation of planets, the modern composition, structure and dynamics of the evolution of planets.		
Abstract of the discipline	Discipline is aimed at the formation of students of modern ideas about the physical processes occurring in the planets, buildings, evolution and methods of studying the planets.		

	When studying the discipline, the following aspects will be considered: review of the solar system; structure and evolution of the planets; orbit dynamics; energy transfer; properties of the atmosphere; planetary surfaces; physics of the magnetosphere; the formation of planets; astrobiology; experimental study of the gravitational, magnetic fields of the earth and planets; propagation of seismic and electromagnetic waves to obtain information about the structure and state of the inner regions of the planets; composition of planetary systems; planetary mass objects; brown dwarfs; satellite planets and planet belts.		
Code FSSS3310	Physics of the Sun and the Solar System		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	6
Aim of the discipline	To form the system of students' knowledge and skills necessary for understanding and analyzing the physical processes occurring in the depths and on the surface of the Sun and their influence on the properties of the interplanetary medium		
Abstract of the discipline	Discipline is aimed at shaping students' understanding of the structure of the Sun, about the processes inside it and in its atmosphere, about the influence of these processes on phenomena in the interplanetary environment. When studying the discipline, the following aspects will be considered: general information about the Sun, rotation of the Sun; general characteristics of the structure of the Sun: the inner layers, the physical conditions in them, the main features; equations of stellar structure: the mass equation, the energy balance equation characterizing the energy release in the solar core, boundary conditions; stellar structure equations: energy transfer equation in diffusion approximation, hydrostatic equilibrium equation, equation of state, expression for opacity; physical conditions in the solar core, features of nuclear reactions in the Sun: the role of the effect of quantum-mechanical tunneling, the reaction rate; the problem of solar neutrino, neutrino oscillations, their rest mass; radiant transfer zone, the distribution of photons in the sun; convection in the sun; solar magnetic fields, the mechanisms of their formation; sun radiation, photosphere, sunspots; the crown, the mechanisms of its heating; concept of solar activity, its manifestations, indices and cycles, solar flares; expansion of the solar corona, solar wind, interplanetary magnetic field; the interaction of the solar		

	wind with the interstellar medium and the magnetospheres of the planets, the concept of the heliomagnetosphere, phenomena excited by solar activity in interplanetary outer space.		
Code SMIP3311	Spectral methods of Planets study		
Prerequisites	FP3309 Physics of Planets	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	6
Aim of the discipline	Acquaintance and study of the main spectral methods of research of planets.		
Abstract of the discipline	Discipline is aimed at developing among students the concept of spectral analysis of the planets. When studying the discipline, the following aspects will be considered: types of spectra; spectral analysis and its use in the study of planets; electromagnetic radiation spectrum; spectral studies in astronomy; capabilities of modern spectral analysis; principles of spectral research methods; basic spectroscopy; the ratio of electronic transitions with oscillatory, adiabatic approximation, the Frank-Condon principle and the probability of electronic-vibrational transitions; basic patterns of light absorption; spectrophotometry in the visible and ultraviolet regions; optimal optical density for measuring the concentration of a substance; features of accurate colorimetry; kinetic analysis and differential spectrophotometry; the study of the fluorescence of objects; infrared spectrophotometry.		
Module «observational astronomy» - 9 credits			
Code NM3303	Radio Astronomy		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	NOG3307 Nonstationary Objects of Galaxy
Credits	3	Term	7
Aim of the discipline	To form in students a holistic and consistent understanding of the theoretical foundations and results of astronomical observations in the radio frequency range, as well as their interpretation.		
Abstract of the discipline	The discipline is designed to shape students' understanding of the modern theory of radio emission mechanisms in space, modern radio astronomy methods and the results of the study of celestial objects in the solar system, in our galaxy and beyond. When studying the discipline, the following aspects will be considered: introduction, basic concepts of radio astronomy; mechanisms of radio emission in astrophysical		

	conditions: the propagation of radio waves in a plasma, the generation of radio emission by plasma oscillations, the bremsstrahlung of an ionized gas; cyclotron radiation, synchrotron radiation, curvature radiation; radiation in the spectral lines of atoms and molecules, molecular maser radiation; radio emission from the quiet Sun; radio emission from the disturbed Sun; radio emission of the moon, planets and comets; Galaxy synchrotron radio emission; emission of interstellar neutral hydrogen, the spiral structure of the galaxy from observations of the 21 cm line; radiation of interstellar molecules in the radio band; radio emission from normal galaxies (in the continuum and in radio links); radio galaxies; quasi-star radio sources; radio telescopes; radio astronomy observatories of the world.		
Code OA4304	Fundamentals of Astrophotometry		
Prerequisites	OA2212 Fundamentals of Astrophysics.	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	5
Aim of the discipline	Acquaintance of students with the methods and tasks of celestial mechanics, to give them an idea of its role and significance in astronomy and in everyday life.		
Abstract of the discipline	Discipline is aimed at developing among students a system of knowledge about the basic laws of the motion of celestial bodies, elements of orbits, types of motion of planets, satellites, asteroids, comets, artificial earth satellites and the use of numerical, analytical and qualitative methods of studying the motion of celestial bodies to solve computational problems. When studying the discipline, the following aspects will be considered: introduction to celestial mechanics; fundamentals of the theory of attraction; potential; extended body; Keplerian elements of the orbit; movement along an ellipse, hyperbola, parabola; stability of the motion of celestial bodies; stability of motion in a many-body problem; two body problem; calculating the ephemeris of celestial bodies; determination of unperturbed orbits; the task of several bodies; osculating elements; analytical integration of the equations of perturbed motion; secular perturbations; limited three-body task; the movement of the natural bodies of the solar system; the movement of artificial celestial bodies.		
Code PEA4305	Semiconductor electronics in astrophysics		
Prerequisites	ORE4203 Fundamentals of radiophysics and electronics	Postrequisites	PdP Pre-diploma internship

Credits	3	Term	7
Aim of the discipline	Mastering the theoretical basis underlying the creation and operation of various semiconductor devices in astrophysics, as well as in imparting the skills of practical use of methods of analysis and calculation.		
Abstract of the discipline	Discipline is aimed at developing students' skills in researching the properties of semiconductors, acquiring knowledge by students in the field of creating modern elemental base of semiconductor electronics. When studying the discipline, the following aspects will be considered: the interaction of electromagnetic waves with matter; registration of light based on the thermal resistance effect; vacuum photocell; light interaction with semiconductors; photoconductivity; semiconductor photodiode at the pn junction; high-speed photo detectors; the effect of defects on the relaxation rate and quantum yield; photoluminescence, excitation and emission spectra, Stokes shift; quantum well photodetectors; methods for increasing the efficiency of solar cells using nanoparticles; light emitting devices; stimulated radiation; semiconductor heterostructure laser; the principle of control of the light flux in the liquid crystal cell.		
Module «kinematics and physics of celestial bodies» - 9 credits			
Code NM3303	Celestial mechanics		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	5
Aim of the discipline	Study of the latest methods of analysis and synthesis of signal detection devices and measurement of their parameters; study of promising methods for determining the coordinates and motion parameters of objects; studying the principles of building advanced radar systems.		
Abstract of the discipline	Discipline is aimed at developing students' skills in applying the methods of the theory of optimal solutions when designing radio information transmission systems, radar and radionavigation systems. When studying the discipline, the following aspects will be considered: directions of development of radar systems; prospects for improving the efficiency of meter radars when using long-term coherent accumulation; the formalism of fuzzy sets and fuzzy integrals in the synthesis of new classes of fractals and multifractals for radar problems; reconstruction of the strange attractor in the reflected radar signals; fractal classification and clustering of optical and radar images of surface and subsurface objects; detection of weakly reflecting ground objects based on the background radar method; radar detection of unobtrusive		

	targets; adaptation of the spectrum of an ultra-wideband probe pulse with monopulse radar; effective area of scattering of objects with multi-position radar observation; the results of digital modeling of the scattering characteristics of objects of complex electrophysical structure and form; methods of digital modeling of the radar characteristics of complex objects against the background of natural and anthropogenic formations; optimal weight processing of radar signals by discrete Fourier transform; operator method of processing information in two-channel polarimetric radars; polarization diagnostics and selective excitation of characteristic waves in the anisotropic ionosphere; passive radar on millimeter waves.		
Code NOG3307	Nonstationary Objects of Galaxy		
Prerequisites	FPZ4306 Physics of variable stars	Postrequisites	PrP Industrial internship
Credits	3	Term	6
Aim of the discipline	To form in students a representation of the properties, characteristics, structure and nature of the variability of non-stationary objects of the Galaxy as a manifestation of the idea of evolution in astronomy.		
Abstract of the discipline	Discipline is designed to form students' understanding of the evolutionary problem in astronomy and cosmology on the example of the evolving objects of our Galaxy. When studying the discipline, the following aspects will be considered: introduction, subject of the discipline, the idea of evolution in astronomy; star formation regions; the W5 star formation region in the constellation Cassiopeia; activity of young stars; T Tauri stars; star associations; open associations; Wolf stars - Raye; tight binary systems; explosions of new stars; planetary nebulae: origin, structure, physical characteristics, evolution, typical representatives; supernova explosions; supernova remnants, stages of their evolution; galactic core, its composition, physical parameters, non-stationary processes.		
Code VFKI3311	Introduction to the physics of cosmic rays		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	5
Aim of the discipline	To form the students a holistic view of the subject and the basic concepts of the physics of cosmic rays (CR), the change in the characteristics of CRs from the sources to the observation point, the main models of the origin of CRs of various energies and the basic mechanisms for accelerating CRs.		

Abstract of the discipline	Discipline is aimed at shaping students' understanding of the role of cosmic rays in nature and science, their research methods, their origin and interaction with the medium all the way from the source to the point of observation, understanding the fundamentals of physics. When studying the discipline, the following aspects will be considered: the subject of physics of cosmic ray, general information about CR, their role in nature and science; CR registration methods; the main characteristics of CR, characteristics on the surface of the Earth; the passage of CR through the atmosphere of the Earth, primary and secondary CR, integral multiplicity; the movement of charged particles in a uniform constant magnetic field; the movement of charged particles in slowly varying magnetic fields; adiabatic invariants of the motion of charged particles in magnetic fields; CR motion in the Earth's magnetic field; the formation and structure of the interplanetary magnetic field; the Boltzmann kinetic equation for the CR motion in the heliomagnetic field; the Fokker-Planck equation for the motion of a CR in the helio-magnetosphere, the modulation mechanisms of CR in the helio-magnetosphere, the energy spectrum and the anisotropy of CRs on the Earth's orbit; mechanisms of accelerating CR; requirements for sources CR; possible sources of cosmic rays of different energies, basic models of the origin of cosmic rays.		
Module «digital technology and data processing in astronomy» - 9 credits			
Code TsKS3309	Digital space communications		
Prerequisites	EM2202 Electricity and magnetism, Optics. Part 1. Electricity and magnetism	Postrequisites	KRR3310 Space Radio location and Radio navigation
Credits	3	Term	5
Aim of the discipline	Formation of students' system of knowledge, skills in the field of digital, satellite communications and technology, instilling skills and abilities to work with literature.		
Abstract of the discipline	Discipline is aimed at teaching students the principles of building communication systems based on modern digital technologies and the basics of designing such systems. When studying the discipline, the following aspects will be considered: functional blocks and basic transformations; autocorrelation of the energy signal; signal transmission through linear systems; formatting of analog information; signal / noise ratio; phase digital keying; demodulation and detection; composition		

	and purpose of satellite communication systems; geostationary orbit; distribution of radio signals; weakening of radio signals in the atmosphere; basic parameters of earth station antennas; fractal-shaped antennas; airborne space repeater module; satellite communications technology.		
Code IEAAS4308	Information- entropy Analysis of Astrophysical Signals		
Prerequisites	OA2212 Fundamentals of Astrophysics	Postrequisites	PdP Pre-diploma internship
Credits	3	Term	7
Aim of the discipline	To form the students a holistic view of the use of information and entropy analysis for the study of astrophysical objects.		
Abstract of the discipline	Discipline is aimed at developing students' knowledge and skills in using information and entropy analysis for the quantitative classification of astrophysical objects of various nature. When studying the discipline, the following aspects will be considered: introduction, analysis of astrophysical signals; time series analysis; methods of the theory of dynamic chaos in astrophysics; statistical signal processing methods; dynamic systems; nonlinear systems; fractal and multifractal analysis of astrophysical signals; determining the fractal characteristics of the interleaved signals; determination of the multifractal characteristics of interleaved signals; concepts of information and entropy; criteria for the degree of self-organization of open systems; generalized metric characteristic; information and entropy analysis of the light curves of variable stars; information and entropy analysis of solar radio emission; normalized entropy of hot stars.		

CONCLUSION OF EXPERTS



THE UNIVERSITY of NORTH CAROLINA
GREENSBORO

College of Arts and Sciences
Department of Physics and Astronomy

321 Petty Building
PO Box 26170, Greensboro, NC 27402-6170
336.334.5844 Phone 336.334.5865
Fax www.uncg.edu/phy

Report on development and expert analysis of the educational program “Astrophysics and Observational Astronomy” on the specialty 5B061100 – “Physics and Astronomy” of Al-Farabi Kazakh National University.

The core curriculum for a bachelor of science on the specialty 5B061100 – “Physics and Astronomy” contains most courses that a student needs to start working as a scientist. I have a few suggestions in order to bring the curriculum closer to a modern level of science.

In particular, I suggest developing a course on collections of observational data (catalogs, databases) and tools to study and analyze them. This course would include the following: introduction to astronomical databases, such as SIMBAD (and Vizier as part of SIMBAD) and NED, MAST (archive of the Space Telescope Science Institute), photometric surveys in the optical (e.g., ASAS-3, ASAS-SN) and infrared (e.g., IRAS, 2MASS, WISE) spectral regions; examples of constructing queries for retrieving data samples and analyzing them with such tools as Excel and Python. Course projects for using the databases need to be developed to check the student skills.

The goal of the existing course “Introduction to cosmic ray physics” is stated to be “to give students the necessary amount of fundamental knowledge in the field of interstellar medium physics.” However, this subject also includes introduction to interstellar gas and dust as well as to processes of getting the matter from stars to the interstellar medium. It may also include basics of interstellar chemistry. Formation of interstellar dust can also be introduced in this course. In my opinion, there is too much emphasis on cosmic rays coming from supernovae, binary systems, galactic nuclei, and pulsars in the current course version. These sources also deliver matter to the interstellar space.

A. Miroshnichenko, Ph.D., D.Sci.

Professor

Department of Physics and Astronomy

University of North Carolina at Greensboro



UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

Instituto de Astronomía



**Report on the development and expert analysis of the education program
“Astrophysics and Observational Astronomy” on the specialty 5B061100
- “Physics and Astronomy” of Al-Farabi Kazakh National University.**

Astronomy and its methods are of great importance in the life of modern society. Issues related to measuring time and providing humanity with knowledge of the exact time, are now solved by special laboratories - time services, organized, as a rule, in astronomical institutions. Astronomical methods of orientation along with others are still widely and used in navigation and in aviation, and in recent years also in space exploration. Calculation and compilation of a calendar, which is widely used in the economy, are also based on astronomical knowledge. The geographical and topographic maps, pre-calculation of offensives sea tides and tides, the determination of gravity in various points of the earth surface for the purpose of discovering deposits of minerals - all this in its based on astronomical methods. Studies of processes occurring on various celestial bodies allow astronomers to study matter in such states of it as have not yet been achieved in terrestrial laboratory conditions. Therefore, astronomy, and in particular astrophysics, closely connected with physics, chemistry, mathematics, contributes to the development of the latter, and they, as is known, are the basis of all modern technology. From my point of view, it is very important that such a program to study Astronomy and Astrophysics was opened at the University.

The curriculum of the astronomy program on the specialty 5B061100 of Al-Farabi Kazakh National University, in general, contains all the necessary sources that are necessary for training specialists in this field of knowledge. Nevertheless, I would like to draw your attention to the fact that a modern specialist in this field needs knowledge not only in the field of astronomy, but also in specialized disciplines as a computer science, programming, knowledge of modern methods of observational astronomy, data processing, and analysis, and also in practical work with modern telescopes and instruments. The latter can be achieved in a cooperation between the specialists and professors of your university with the staff Fesenkov Astrophysical Institute, Kamenskoe Plateau Observatory, Assy-Turgen Observatory and Tien Shan Astronomical Observatory, and foreign specialists. Modern astrophysics is developing at a very fastly, public astronomical databases are being formed with information on

a huge number of sources and, as a result, all this requires from future specialists knowledge in the field of working with databases and modern computer programs for analyzing and processing astronomical information such as IRAF, astronomical applications of python, and modern methods of computer simulation of astrophysical phenomena and processes. Especially want to pay attention that most of the scientific programs are implemented in the operating system UNIX/LINUX, the ability to work in which is also necessary for a modern specialist.

Publication of scientific results in astrophysics requires the ability to edit and prepare a publication using such editing packages as Latex that is generally accepted in the modern scientific community. In this vein, it seems necessary to prepare all student's works and publications with the using of Latex.

From my point of view the content of curriculum of the educational program can be improved. It seems necessary to restructure of modules and disciplines included into Elective Component (EC) in Major Disciplines (MD). Therefore, steps are described below is recommended:

·Change the title of module «Astrophysics» onto «Cosmology».

Its close related with disciplines in the module. Structure and evolution of the Universe, Fundamentals of Cosmology and Extragalactic astronomy are main parts of general cosmology. Hence, module renaming will match to content.

·Replace the «Celestial Mechanics» discipline with «Radio astronomy», in the «Observational astronomy» module.

This is related to the material which studied in the course. As so as radio astronomy methods and analysis are more suited to observational astronomy module.

·Hereinafter, abandon the "Introduction" prefix in the titles of the Major Disciplines also recommended.

Reason is incongruous of using such, general word in titles of majors by profile 5B061100 - Physics and Astronomy.

·Rename the module as «Kinematics and physics of celestial bodies» instead of «Radio astronomy».

This step will unite disciplines into a single, logical module, under one title.

·Transfer the «Celestial Mechanics» discipline from «Observational astronomy» module to «Kinematics and physics of celestial bodies» module.

·Change the title of «Introduction to the physics of cosmic rays» discipline, which included in «Cosmic rays» module and move into «Kinematics and physics of celestial bodies» as «Physics of cosmic rays».

·Rename the «Cosmic rays» module onto «Digital technology and data processing in astronomy».

Modern astronomy is impossible without knowledge of the basics of digital technology and data processing methods. Therefore, courses included in the educational program can be well aggregated under this name.

·Move the «Information-entropy Analysis of Astrophysical Signals» discipline to «Digital technology and data processing in astronomy» module.

Here, want to pay attention to implementation of the course content. Informational entropy analysis covers the basics of digital signal processing, including Fourier, wavelet and correlation analyzes. The methods of probability theory and analysis of signals of different nature also mentioned.

And lastly, in modern science, it is important not only to get a scientific result but also be able to bring it to the scientific community and the public. The ability to correctly create a presentation of the result, the ability to present it in a short and clear manner to the listener can only be achieved through public presentations by students at seminars, scientific conferences and/or public lectures. The organization and participation of students in such activities are highly recommended and should be included in the educational process for this specialty.

Dr. Sergey Zharikov (Serguei Jarikov)



Chef of Department of Observational Astronomy
of Astronomical Institute of National Autonomy University of Mexico.



中国科学院新疆天文台

XINJIANG ASTRONOMICAL OBSERVATORY
CHINESE ACADEMY OF SCIENCES

Report on the development and expert analysis of the education program “Astrophysics and Observational Astronomy” on the specialty 5B061100 – “Physics and Astronomy” of al-Farabi Kazakh National University.

Generally, the educational program and all the courses included in it are compiled according to modern, classical textbooks in the relevant fields. The course material is presented clearly and will be understandable for graduates and beginner physicists. The program covers modern trends in technology and teaching material according to Western standards. Serious assumptions that could adversely affect the quality of training are not available. With full confidence I can say that the presented educational program and courses can be applied for the training of qualified personnel in the specialty "physics and astronomy".

To improve the quality of the material presented and increase the competitiveness of the graduates, I recommend the following steps:

Briefly mention in the introduction part of the course about current and future projects in the relevant fields. Also provide some additional references to reviews and research plans in the list of “References and resources”. This step will help the student to represent the real scope of the discipline and can serve as a motivation for effective learning of the subject. Knowledge about the state of science "for today" is very important.

Scientific and pedagogical orientation of the educational program makes it necessary to know the latest, topical trends in the research field. This will be helpful for expanding the outlook of the students. It would be an introduction for choosing an interesting field in scientific researches. Also, this knowledge will be useful for future professionals in teaching, for the preparation of competitive personnel, whose knowledge will meet the requirements for specialists in the field. In this regard, I recommend pointing out links to international, quoted databases of scientific articles, for example:

adsabs.harvard.edu/abstract_service.html.

This is the largest and all-encompassing database of scientific works on the physics and astronomy specialty. The data from this source are available also in their author's version, and the abstracts are published ahead of the cited astronomical journals with high impact factors. Also, this source includes references to an articles in archive of preprints: arxiv.org. In my personal conviction, it must be indicated in every syllabus.



When performing laboratory works it is convenient to use data from open scientific projects and surveys. It is important to show in the training syllabus some links to open databases of observational data. Organizations which publish this data also readily share with the results of their surveys, observations and provide whole sets of tools for their processing and analysis. As sources of such data can serve a project and observatory like:

- Gaia (*Global Astrometric Interferometer for Astrophysics*), in optical wavelength
- IRAM (*International research institute for radio astronomy*),
- ALMA (*Atacama Large Millimeter Array*),
- GBT (*Green Bank Telescope*),
- Effelsberg radio observatory at Max Planck Institute for Radio Astronomy.

This would open up the possibility for students to practice with real data for real scientific laboratory works.

I recommend including some practical task on the basis of linux-like systems. It will contribute to shifting the main accent from windows to linux-like system, where it will be possible. This advice applies to graduate students of high courses (3-4 courses). I want to note that for the beginners a change of the operating system can cause some inconvenience. However, I want to assure that this transformation will only have a favorable effect on the level of qualifications of the trainees. This is due to a number of advantages of such systems as open source code, general and free accessibility for a wide range of users and the availability of support from user community. Alternatives to the windows based programs used in the courses are available. For example, GNU Octave is a full-fledged analog of MATLAB for linux. Thus, it becomes possible to use the high-level Python programming language too. Conducting research on such freely available platforms is an integral part of any research, and it is very popular in the scientific community. In general, this trend is caused by the possibility for free distribution of author's solutions and additions widely.

On the specific syllabus of the educational program: "Introduction to Radio Astronomy". It is very gratifying that the graduate program includes the practice of the GILDAS (*Grenoble Image and Line Data Analysis Software*) family of software: ASTRO (*A Software To prepare Observations*), CLASS (*Continuum and Line Analysis Single -dish Software*) and GREG (*GREnoble Graphics*) supported by IRAM. These are main windows-based programs for the primary reduction of "raw" astronomical data in many scientific organizations, at the Beijing Observatory in particular. Also, you can use the IDL software which



中国科学院新疆天文台

XINJIANG ASTRONOMICAL OBSERVATORY
CHINESE ACADEMY OF SCIENCES

is an analog of MATLAB, optionally. In my opinion, it would be effective to teach the basics of such programs for Linux as AIPS (*Astronomical Image Processing System*) and CASA developed and supported by NRAO (National Radio Astronomy Observatory) which are designed for serious astronomical research on the bases of several laboratory tasks.

At the last, I attach a brief list of the disciplines taught to students in the research and scientific universities of the People's Republic of China which recommended by the Chinese Academy of Sciences for students in Physics and Astronomy.

Dr. Jarken Esimbek
Deputy Director of Xinjiang Astronomical Observatory, CAS

E-mail: jarken@xao.ac.cn
Postal Address: 150, Science 1-Street, Urumqi, Xinjiang 830011, China.
Tel: 86-0991-3689002
Fax: 86-0991-3838628



中国科学院新疆天文台
XINJIANG ASTRONOMICAL OBSERVATORY
CHINESE ACADEMY OF SCIENCES

**Astronomy related courses at
colleges and universities of People's Republic China**

Peking University:

- Stellar structure and evolution
- Astrophysical radiation mechanisms
- Astronomical literature review
- Galaxy formation
- Astrophysics
- Astronomy technology and methods
- Stellar atmosphere and celestial spectrum
- Introduction to cosmology
- Particle physics
- Physical cosmology

Nanjing university:

- Celestial mechanics
- Spherical astronomy
- Physics of celestial bodies
- Theoretical astrophysics
- An introduction to galaxies
- Physics of X-ray binaries
- History of astronomy
- Multiband astronomy in deep space probe
- Radio astronomy



中国科学院新疆天文台

XINJIANG ASTRONOMICAL OBSERVATORY
CHINESE ACADEMY OF SCIENCES

**Astronomy related courses at
colleges and universities of People's Republic China**

Universities of Chinese academy of science:

- Astrophysics in radiation process
- Radio telescopes and implementation
- Galaxy astronomy
- Introduction to modern Sun physics
- Introduction to planetary science
- Stellar atmosphere and line analysis
- Astronomical geodynamics
- Astrometry and its application
- Astronomical optic systems
- Stellar internal structure and evolutional physics
- Multiband astronomical observations and data processing
- Spectrometers and implementation
- Gravitation and cosmology
- Galaxy dynamics
- Telescope design
- Introduction to radio astronomy
- High-energy astrophysics
- Plasma astrophysics
- Measuring adjustment

Beijing University:

- Introduction to astronomy
- Measurement astrophysics
- Spectral astronomy
- Sun physics
- Advanced research in astrophysics
- Gravity and cosmology



INSTITUTO DE CIENCIAS NUCLEARES
UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO
CIRCUITO EXTERIOR C.U. A. POSTAL 70-543. 04510 MÉXICO. D.F.

Evaluation of the Bachelor Educational Program

Physics and Astronomy

at the

Al-Farabi Kazakh National University

presented by

Prof. Hernando Quevedo
Institute of Nuclear Sciences
National Autonomous University of Mexico
and

Department of Physics
University of Rome "La Sapienza"
E-mail: quevedo@nucleares.unam.mx

Physics and Astronomy is one of the bachelor programs offered at the Al-Farabi Kazakh National University (KazNU). The teaching plan for this program can be divided into two main blocks. The first block includes general education and basic disciplines with both obligatory and elective courses. After a general introduction to the main topics of astronomy and astrophysics, the second block of the program offers two specialties, namely, observational astrophysics and theoretical astrophysics. The preparation and defense of a scientific thesis is considered as the last requirement to become the B.S. degree.

The general education category of the first block consists of five obligatory and four elective courses aimed to strengthen the knowledge of the local Kazakh culture and of two foreign languages, namely, Russian and English. It is worth mentioning that the general education category includes two courses of history and philosophy that are essential to develop the historical and cultural belonging of students, aspects that are usually not sufficiently emphasized in the programs of most universities worldwide. This can be considered as a very positive facet of the educational program at KazNU. The categories of elective, obligatory and interdisciplinary courses contain a considerable number of subjects which deal with topics of different nature, giving students the possibility of specializing for future work in educational institutions, industry or research. Courses like economics and sociology are of special importance for students who



would like to join the productive market specially of private companies. In addition, the general education disciplines are complemented by profession practices and physical culture.

Although this area is certainly a very important aspect of the students' education, I consider that the number of courses related to general education is quite high, taking a large amount of educational time that could lead to decreasing the scientific level of KazNU students, when compared to the levels at other international universities. Below, I will give a specific recommendation in this regard.

The category of basic disciplines is essentially dedicated to the study of general physics and includes courses in elementary mechanics, molecular physics, electricity and magnetism, optics, fundamentals of radio physics and electronics. A comprehensive physics and mathematical education is provided by the 21 additional courses that are included in this category. It contains courses in concepts of modern natural science, physical bases of electronics, computer modeling of physical processes, fundamentals of astrophysics, general astronomy, galactic astronomy, electrodynamics, quantum mechanics, physics of condensed matter, atom physics and nuclear physics. Moreover, the main aspects of mathematical sciences are studied in courses about analytic geometry and linear algebra, mathematical analysis, theory of probabilities and statistics, fundamentals of vector and tensor analysis. The learning units described in the outline of these courses are classified in a logical way and agree with the standards recognized in major universities. An important aspect of the physical education offered in this program is that most courses on general physics are accompanied by laboratory works that serve to put into practice the theoretical aspects of the courses.

The second block of the program starts in general during the seventh semester of the curriculum and is dedicated mainly to astrophysics and cosmology. It also offers students the possibility of selecting a specialty in accordance with their own interests and personal purposes.

The specialty of theoretical astrophysics includes nine special courses which cover practically all the main aspects of modern astrophysics. Three courses are dedicated to the study of the Sun and the solar system, the physics of planets and spectral methods. It is important to notice that the topics considered in the course of spectral methods are especially oriented to the study of planets not only at the introductory undergraduate level, but they also contain aspects that are usually left for more advanced courses at the graduate level. The physics of stars is studied in three courses that cover the main aspects of the structure, dynamics and evolution of stars. Finally, three courses are dedicated to the study of large scale effects in the Universe; they include extragalactic astronomy, structure and evolution of the Universe and fundamentals of cosmology. The topics contained in the outline of each course are organized in a logic manner and correspond to the state-of-the-art scientific knowledge.



The learning units of the course in fundamentals of cosmology cover quite well all the phenomenological aspects of this field; however, modern cosmology contains a very important theoretical component that is based upon the theory of general relativity, which is not included in the program. Moreover, due to the rapid development of satellite-based telescopes and radio telescopes, during the last few decades, cosmology has transformed from a pure theoretical branch of physics to an observational science that has led to drastic changes in the understanding of the Universe. Therefore, I propose to add a new course on modern cosmology that would contain an introduction to general relativity, the standard cosmological model, including the era of inflation and the Big Bang, and some basic aspects of observational cosmology.

The specialty of observational astrophysics contains nine courses which are divided into three groups. The first group includes all the main aspects of celestial mechanics, astrophotometry and electronics. This last course is based upon the use of semiconductors, which are the most commonly used electronic devices for astrophysical research at the international level. The second group is dedicated to the study of radio astronomy and contains an introductory course to the physics of non-stationary galactic objects as well as to the applications of information theory to the analysis of astrophysical signals. The learning units of this last course are particularly important because they introduce the students to the physical applications of information theory, an area that has been neglected in physics for many years and only recently has found some applications. It is interesting that the program of Physics and Astronomy at KazNU has incorporated so early this new scientific trend. Finally, the group of cosmic rays includes also introductory courses in satellite communication and radio navigation.

The last step towards the B.S. degree consists in writing and defending a scientific thesis under the supervision of a faculty member. This is a particularly important requirement that allows the students to prepare themselves for continuing their careers either in state or private research institutions as well as in industrial enterprises. Interestingly, the students can select the theme of their thesis from a pool that contains a large number of topics in observational and theoretical astrophysics. This is an important advantage for students because they have the opportunity to select topics that agree with their personal goals.

In summary, the program Physics and Astronomy satisfies all the requirements for a bachelor degree in the field of physical and astronomical sciences. The learning units agree with other similar programs of major universities worldwide. The courses that handle spectral methods and information theory are beyond the scope of the undergraduate programs of other international universities and are usually included in graduate programs. This certainly gives the KazNU students an advantage, when compared with students of other high education institutions abroad. The program also contains additional subjects that contribute to develop the Kazakh cultural



belonging of students. Finally, to further improve the competencies of the students at the international level, I have the following recommendations:

- a) Reduce the number of general educational courses to decrease the time that students dedicate to the learning of human and social aspects of education.
- b) Introduce a new course in modern cosmology that should include a brief introduction to general relativity, the essential aspects of the standard cosmological model, including the era of inflation and the Big Bang, and some basic features of observational cosmology. To this end, I recommend the following textbooks which are used for teaching in several universities worldwide:
 - 1) B. Schutz "A first course in general relativity" (Cambridge University Press, 2009).
 - 2) J. Foster and J. D. Nightingale "A short course in general relativity" (Springer-Verlag, 2006).
 - 3) A. Liddle "An Introduction to modern cosmology" (John Wiley & Sons Ltd., 2003).
 - 4) J. Rich "Fundamentals of cosmology" (Springer Verlag, 2009).

I hope the above comments and recommendations will contribute to maintain the high educational level of the program of Physics and Astronomy at KazNU.

Sincerely,

Prof. Hernando Quevedo

Dr. Olga Zakhochay

Researcher

Department of Planet and Star Formation

Tel: +49-6221-528-292 e-mail: zakhochay@mpia.de



**Review of the educational program “Astrophysics and Observational Astronomy”
on the specialty 5B061100 – “Physics and Astronomy”
of Al-Farabi Kazakh National University**

26.09.2018

The educational program “Astrophysics and Observational Astronomy” includes the subjects and disciplines required for the young researcher to start the scientific carrier, giving the introduction to the most important physical processes and classical methods of their study. The program also includes the General Educational disciplines that are important for the fundamental education, that classical University should give.

I have some suggestions, that are listed below.

1) During the first or second educational year I would suggest to have a course called “The Structure of the Scientific Research”. This course should include the overview about the main stages of the scientific investigations from the point of the formulation of the scientific task, through the scientific study itself and to the moment of the presentation of the result. Such that it will become clear what is a difference between the referred paper, proceeding and the abstract. This course should also prepare young scientists to present their work at conferences and explain what is the difference between the research school, workshop, conference, assembly, etc.; as well as give a direction on how to find proper scientific meeting to present their results or how to find the place for the best research practice.

2) The program includes 4 disciplines related to the languages: Kazakh (Russian) Language (code: K(R)Ya1104) and Professionally Oriented Kazakh (Russian) language (code: POK(R)Ya2206); Foreign Language (code: IYa1103) and Professionally Oriented Foreign language (code: POIYa2207). I find these disciplines repetitive, especially accounting that all the students previously have studied the native and foreign languages in school.

I would suggest to replace at least one of the native language courses to the Business Kazakh (Russian) language. The course that will prepare the students to write the official letters, statements, reports; on how the templates of different official documents look and which formulations are commonly used in such documents.

For the Foreign language (I believe that it should be English by the definition, as far as all international astronomical journals publish in English) the Professionally Oriented course is obviously essential. It should be the course that explain on how to understand the scientific language and on how to use it. But instead of just a general course of the foreign language I would suggest to have a special course dedicated also to the scientific communication (writing the official letters and e-mails) and preparing the basic documents (like CV, motivation letters, resume, etc.). I would suggest to have this course as a practice, such as by the end of it students



MAX-PLANCK-GESellschaft

would have a basic set of their own documents and could use them later to apply for the research schools, grants or future studies in other foreign universities and institutes.

3) Additionally I suggest to have a special course about the history of science and the Astronomy in particular. Such course should not only give an introduction about the history of the science itself, but also give an overview about the modern research centers and Universities.

4) Also it is very important to have a special practicum that will give an introduction on how to use the modern databases, like SAO/NASA ADS, SCOPUS, SIMBAD – for a literature search and of course special astronomical databases like VIZIER, GAIA data releases, Exoplanets databases, ESO archives and many others. This course might be reasonably short, but it should give to the student proper directions on how to find and how to use the literature and archive data.

5) For the course “Computer modeling of physical processes” I recommend additionally to have an overview about the most usable programming languages, that will explain the specificity of each of them and for which task which language would be the most efficient. In particular I would recommend to dedicate some time to Python, as far as it is commonly used programming language in science nowadays.

6) For the special astronomical courses I would recommend to add the one called “Introduction to the Exoplanetary Science”. By the meaning it is close to the course of the “Physics of Planetary systems”. But exoplanetary science has developed significantly during last 20 years. This course should include the overview about the methods of the exoplanets search and the modern theory of the stellar and planetary systems formation. It is also one of the most popular modern directions of the astronomical studies.

As a basis I would suggest to use the topics that are listed in the separate document attached to this review. For the preparation of the course on the planetary formation I would recommend the lectures of Philip Armitage and Cornelius Dullemond that are publicly available and are updated regularly by authors. For the basis of the exoplanets search methods lectures I recommend to use books of Sara Seager "Exoplanets" and Michael Perryman "The Exoplanet Handbook" (2nd edition is available since August 2018).

7) I have a general comment to the courses of Astrophysics and Observational Astronomy. I think that during the studies in the University students should attend the lectures of the both disciplines set. Because the gap in between the “modelers” and “observers” seems to be a classical problem of the Astrophysics in general. Models help to understand the data, the observations confirm or falsify the theories. Observers need to understand where to point the telescopes and the modelers should understand how their data were taken.

In general the educational program “Astrophysics and Observational Astronomy” meets all requirements for the program of the Bachelor Degree on specialty “Physics and Astronomy”.

③- Dr. Olga Zakhzhay



MAX-PLANCK-GESellschaft

**Suggestions for the course «Introduction to the Exoplanetary Science»
to be included in educational program «Astrophysics and Observational Astronomy»
on the specialty 5B061100 – «Physics and Astronomy»
of Al-Farabi Kazakh National University**

The aim: To form the basic concepts about the methods of the exoplanets search and the modern theory of the stellar and planetary systems formation. It is also one of the most popular modern directions of the astronomical studies.

The topic titles:

Lecture 1. Introduction to the Exoplanetary sciences. Planet categories. Historic overview.

Practice 1. The Extrasolar Planets Encyclopaedia (<http://exoplanet.eu/>)

Lecture 2. Planetary systems formation: I. Protostellar and Protoplanetary disks. Physical properties and evolution. Observational methods.

Practice 2. Tasks to the topic of lecture.

Lecture 3. Planetary systems formation: II. Debris disks. Physical properties. Observational methods.

Practice 3. Tasks to the topic of lecture.

Lecture 4. Planetary systems formation: III. Peculiarities of the giant and rocky planets formation. Observational methods.

Practice 4. Tasks to the topic of lecture.

Lecture 5. Methods of exoplanets search: I. Radial Velocity.

Practice 5. Computations of the planetary characteristics from the radial velocity data.

Lecture 6. Methods of exoplanets search: II. Transit.

Practice 6. Kepler space mission. Work with NASA exoplanets archive (<https://exoplanetarchive.ipac.caltech.edu/>)

Lecture 7. Methods of exoplanets search: III. Astrometry.

Practice 7. GAIA space mission. Work with GAIA data release 2 (<https://www.cosmos.esa.int/web/gaia/dr2>)

Lecture 8. Methods of exoplanets search: IV. Microlensing.

Practice 8. Tasks to the topic of lecture.

Lecture 9. Methods of exoplanets search: V. Timing.

Practice 9. Tasks to the topic of lecture.

Lecture 10. Methods of exoplanets search: VI. Imaging.

Practice 10. Exploring the ESO (European Southern Observatory) data archive (<http://archive.eso.org/cms.html>)

Lecture 11. Planet categories and physical properties.

Practice 11. Exploring the exoplanet orbit database (<http://exoplanets.org/>)

Lecture 12. Stars hosting the exoplanets, their physical characteristics. Star-planet interactions.

Practice 12. Exploring the SIMBAD Astronomical Database (<http://simbad.u-strasbg.fr/simbad/>)

Lecture 13. Brown dwarfs and free floating planets.

Practice 13. Tasks to the topic of lecture.

Lecture 14. Specific planet classes and peculiarities of their formation.

Practice 14. Tasks to the topic of lecture.

Lecture 15. The Solar System, putting the knowledge in a context.

Practice 15. Tasks to the topic of lecture.

The literature:

- Michael Perryman "The Exoplanet Handbook",
- Sara Seager "Exoplanets",
- Sara Seager "Exoplanet Atmospheres: Physical Processes",
- Philip Armitage "Astrophysics of Planet Formation",
- Henrik Beuther et al. "Protostars and Planets VI (Space Science Series)",
- Patrick Cassen, Tristan Guillot, Andreas Quirrenbach "Extrasolar Planets",
- Valerio Bozza, Luigi Mancini, Alessandro Sozzetti "Methods of Detecting Exoplanets: 1st Advanced School on Exoplanetary Science",
- Ray Jayawardhana "Strange New Worlds: The Search for Alien Planets and Life beyond Our Solar System".

 Dr. Olga Zakhozhay

**Выписка из протокола № 1
заседания учебно-методического объединения
Республиканского учебно-методического совета
высшего и послевузовского образования
на базе КазНУ им. аль-Фараби (далее УМО РУМС)
от 20 ноября 2018 г**

ПРИСУТСТВОВАЛИ: Зам. председателя УМО РУМС на базе КазНУ им. аль-Фараби, проректор по учебной работе Хикметов А.К., ученый секретарь УМО РУМС Сыргакбаева А.С., разработчики образовательной программы «Физика и астрономия».

СЛУШАЛИ:

- Зам. председателя УМО РУМС на базе КазНУ им. аль-Фараби, проректора по учебной работе Хикметова А.К.: В 2018 гг. в соответствии с договором № 183 от 14.05.2018 года КазНУ им. аль-Фараби было поручено разработать 10 образовательных программ на английском языке (далее ОП), в их числе ОП «Физика и астрономия». Слово предоставляется декану физико-технического факультета КазНУ им. аль-Фараби, д.ф.-м.н., профессору Давлетову А.Е.

- Давлетов А.Е.: ОП «Физика и астрономия» была разработана в рамках выполнения пункта 133 Плана мероприятий по реализации Государственной программы развития образования и науки Республики Казахстан на 2016-2019 годы, в соответствии с Законом Республики Казахстан «Об образовании» от 27 июля 2007 года № 319-III, нормативно-правовыми актами МОН РК, с технической спецификацией по разработке образовательных программ на английском языке. В период разработки программы в МОН РК было отправлено 2 промежуточных отчета и drafts ОП – 1 июля 2018 г., 1 октября 2018 г. Все дисциплины и модули ОП были согласованы с ведущими отечественными и зарубежными учеными и экспертами, а также работодателями.

Слово предоставляется координатору ОП «Физика и астрономия» доктору PhD Ибраимову М.К.

Ибраимов М.К.: В полном соответствии с требованиями технической спецификации для разработки ОП «Физика и астрономия» были привлечены ведущие отечественные и зарубежные специалисты, владеющие английским языком и опытом работы в сфере высшего образования: Ибраимов М.К., Жанабаев З.Ж., Изтлеуов Н.Т., Наурзбаева А.Ж., Хохлов С.А., Каламбай М.Т., Куратов К.С., Агишев А.Т., Кайраткызы Д., Майлыбаев А.Т., Dr. Miroshnichenko Anatoly - University of North Carolina at Greensboro, North Carolina, United States Professor of Dept. Physics & Astronomy. Dr. Jarken Esimbek – Xinjiang Astronomical Observatory, CAS, Urumqi, Xinjiang, China, Deputy Director of XAO, CAS. Dr. Zaks Michael - Humboldt University of Berlin,

Germany (Humboldt-Universität zu Berlin), Professor of Department of Physics
 Dr. Quevedo Hernando - National Autonomous University of Mexico, Mexico City,
 Mexico (Universidad Nacional Autónoma de México). Dr. Zharikov Sergey -
 National Autonomous University of Mexico, Mexico City, Mexico (Universidad
 Nacional Autónoma de México). Отечественные учебные заведения: Беков А.А.
 - д.ф.-м.н., профессор КазНУ им. К. И. Сатпаева. Турмухамбетов А.Ж. -
 д.ф.-м.н., профессор КазНУ им. К. И. Сатпаева. Представители
 работодателей: Чечин Л.М. - профессор, д.ф.-м.н. ДТОО «АФИФ»
 (Астрофизический институт им.Фесенкова). Сомсиков В.М. - д.ф.-м.н.,
 профессор ДТОО Институт ионосферы. Валиуллин Р.Р. - к.ф.-м.н.,
 заместитель директора по научно-исследовательской работе АО «НЦКИТ».
 Иманбаева А.К. - к.ф.-м.н., ученый секретарь, ДГП на ПХВ «НИИЭТФ». Во
 время командировки были ознакомлены с учебными программами
 университетов Германии по специальности «Физика и астрономия», а также с
 деятельностью Max-Planck-Institut für Astronomie для дальнейшего
 сотрудничества.

Хикметов А.К.: ОП «Физика и астрономия» разработана в
 соответствии с требованиями технической спецификации, структура и
 содержание ОП согласованы с работодателями, сроки выполнения работ
 соблюдены. Предлагаю одобрить ОП на английском языке «Физика и
 астрономия». Прошу коллег высказать свое мнение. Принято единогласно.

ПОСТАНОВИЛИ:

Одобрить образовательную программу на английском языке «Физика и
 астрономия».

**Зам. председателя УМО РУМС
 на базе КазНУ им. аль-Фараби,
 проректор по учебной работе**

**Декан физико-технического
 факультета, д.ф.-м.н., профессор**

Ученый секретарь УМО РУМС

А.К. Хикметов

А.Е. Давлетов

А.С. Сыргакбаева

**«ҰЛТТЫҚ ҒАРЫШТЫҚ ЗЕРТТЕУЛЕР МЕН
ТЕХНОЛОГИЯЛАР ОРТАЛЫҒЫ»
АКЦИОНЕРЛІК ҚОҒАМЫ**

**«В.Г.ФЕСЕНКОВ атындағы
АСТРОФИЗИКАЛЫҚ ИНСТИТУТ»
ЕНШІЛЕС ЖАУАПКЕРШІЛІГІ
ШЕКТЕУЛІ СЕРІКТЕСТІГІ**



**АКЦИОНЕРНОЕ ОБЩЕСТВО
«НАЦИОНАЛЬНЫЙ ЦЕНТР КОСМИЧЕСКИХ
ИССЛЕДОВАНИЙ И ТЕХНОЛОГИЙ»**

**ДОЧЕРНЕЕ ТОВАРИЩЕСТВО
С ОГРАНИЧЕННОЙ ОТВЕТСТВЕННОСТЬЮ
«АСТРОФИЗИЧЕСКИЙ ИНСТИТУТ
ИМ. В.Г. ФЕСЕНКОВА»**

050020, Алматы қ., Каменское плато, Обсерватория 23
тел./факс.: 8 (727) 260-75-90, e-mail: secretariat@aphi.kz

050020, г. Алматы, Каменское плато, Обсерватория 23
тел./факс.: 8 (727) 260-75-90, e-mail: secretariat@aphi.kz

08. 12. 2018 № 02-10-19/230

Рецензия

на образовательную программу по специальности
«5B061100 – Физика и Астрономия»

Образовательная учебная программа по специальности «5B061100 – Физика и Астрономия» охватывает основные разделы общей физики, общей астрономии, астрофизики и космологии.

Программа подготовлена с учетом необходимых требований, предъявляемым к образовательным программам, выдвигаемым министерством образования и науки республики Казахстан. В рамках следующих нормативных актов:

- Закон Республики Казахстан «Об образовании» (№319-III от 27 июля 2007 г. в редакции Закона РК от 24.10.11 г. № 487-IV, с изменениями и дополнениями по состоянию на 04.07.2018 г.);
- Государственный общеобязательный стандарт высшего образования, утвержденный постановлением Правительства Республики Казахстан от 23 августа 2012 года №1080, с изменениями от 13 мая 2016 года № 292;
- Постановление Правительства Республики Казахстан от 24 декабря 2007 года №1270 "Об утверждении Правил государственной аттестации организаций образования";
- Типовой учебный план по специальности 5B061100 – Физика и астрономия, утвержденный приказом Министра образования и науки Республики Казахстан от 5 июля 2016 года № 425;

Английский язык подготовки студентов, высокая гибкость выбора индивидуальных образовательных траекторий обучающимися, а также наличие аналогичных курсов в образовательных программах зарубежных университетов делают настоящую программу высокоэффективной в подготовке бакалавров естествознания по специальности.

3173

Большой объем практических и лабораторных занятий по профильным дисциплинам специальности нацелены на укрепление пройденного, теоритического материала на реальных, наблюдательных данных. Работа с современным, широко распространённым среди научного сообщества, программным обеспечением создают надежную основу для ведения успешной научно исследовательской деятельности или продолжения обучения в магистратуре по исследовательскому направлению, после получения степени бакалавра.

Наличие производственных и преддипломных практик и сотрудничество с исследовательскими институтами способствует воспитанию научных кадров уже на старших курсах обучения и благоприятно влияет на обмен опытом между учебным заведением и исследовательскими центрами. Студенты получают реальную проверку полученных знаний и могут претендовать на вакантные позиции.

Структура и наполнение отдельных силлабусов соответствует международным образовательным программам по содержанию. Это позволяет реализовать процессы обмена студентами, зарубежных стажировки подготовки выпускников по двух дипломным программам на основе настоящей программы.

Разработанная образовательная программа рекомендуется для внедрения в высших учебных заведениях для подготовки бакалавров по специальности «5В061100 – Физика и Астрономия».

д.ф.-м.н., профессор,
АФИФ им. В.Г.Фесенкова

Чечин Л.М.



Подпись заверяю инспектор по кадрам Агафонова З.В.

Рецензия

на образовательную программу
в рамках специальности бакалавриата «5В061100 – Физика и Астрономия»

Настоящая образовательная программа по специальности «Физика и астрономия» разработана на основе Типового учебного плана специальности 5В061100 – Физика и астрономия (от 23 августа 2012 года с изменениями от 13 мая 2016 года) в соответствии с международными документами в сфере высшего образования, рекомендациями программы ECTS Users' Guide (Руководство по использованию ECTS), «Настройка образовательных структур в европейских вузах» («Tuning Educational Structures in Europe») и устанавливает требования к содержанию образования через результаты обучения, объему учебной нагрузки и уровню профессиональной подготовки бакалавров. Образовательная программа разработана с учетом сопоставления трудоемкости учебной нагрузки в соответствии с требованиями Болонской декларации.

Подготовка специалистов через результаты обучения в виде сформированных компетенций позволяет готовить конкурентоспособных кадров. Программа нацелена не только на получения обучающимися конкретных знаний, а делает акцент именно на приобретение необходимых умений и навыков.

Образовательная программа в целом имеет четкую логическую последовательность изучаемых дисциплин и способствует комплексной подготовке выпускников. При этом программа обладает значительной гибкостью в выборе будущей специализации самостоятельно, самими студентами сложенных из требований рынка, желания обучающегося и возможностей университета. В перспективе зарубежного сотрудничества и обмена опытом стоит подчеркнуть наличие одноименных и схожих по содержанию траекторий и отдельных дисциплин в программах бакалавриата ведущих исследовательских университетов США, Европы и Китая. При этом, английский язык обучения делает все виды научного и профессионального сотрудничества между ВУЗами возможным.

К разработке образовательной программы были привлечены зарубежные консультанты. Специалисты в сфере образования и науки, работодатели и исследовательские институты. Это определило состав и структура каждой, отдельной дисциплины, которые были детально проработаны с учетом современного состояние физического и астрономического образования, международных требований к квалификации бакалавра по специальности и области научных интересов отечественных научно-исследовательских организаций. Например, сегодняшние тренды и тенденции, как научные достижения последних лет уже включены в содержание курсов. Это вопросы, касающиеся гравитационных волн, темной

энергии и ускоренного расширения вселенной – переднего рубежа исследовательского интереса.

Образовательная программа предназначена для подготовки высококвалифицированных специалистов в области экспериментальной, теоретической и прикладной астрономии и космофизики, а также в области смежных естественных и технических наук. В области образования, в том числе области педагогики, теории и методики обучения физике и астрономии в средних и высших учебных заведениях. Специалистов, обладающих техническими умениями и навыками по контролю, управлению и техническому обслуживанию исследовательского и научного оборудования, устройств и приборов для обсерваторий, астрономических станций и нужд военной и оборонной промышленности, способных к разработке программно-аппаратных комплексов с применением современных информационно-коммуникационных технологий для конкретных нужд и его обслуживанию.

При разработке образовательной программы учтены пререквизиты специальности, а наличие междисциплинарной направленности позволяют продолжить обучение по группе специальностей на магистратуре и PhD докторантуре, как в Казахстане, так и за его пределами.

Данная образовательная программа рекомендуется для реализации в высших учебных заведениях, для подготовки обучающихся по специальности «5В061100 – Физика и Астрономия».

д.ф.-м.н., профессор,
Заведующий лабораторией
физики геокосмических связей,
ДТОО Институт ионосферы



Сомсиков В.М.

**Экспертное заключение
на образовательную программу «Физика и Астрономия» по
специальности 5В061100- «Физика и астрономия»
Казахского национального университета им. аль-Фараби**

Общая характеристика образовательной программы.

Образовательная программа составлена для подготовки высококвалифицированных специалистов в области физики, астрономии, обладающих фундаментальными знаниями, навыками и умениями применения экспериментальных, теоретических и численных методов научных исследований. Образовательная программа представлена на казахском, русском и английском языках, содержит разделы общеобразовательных, базовых и профилирующих дисциплин, включающих обязательные компоненты и компоненты по выбору. Общеобразовательные дисциплины дают подготовку полноценных специалистов, в результате изучения и освоения образовательных модулей, включающих инструментальный модуль, который дает знание казахского, русского, английского языков и информационно-коммуникационных технологий, необходимых для будущих специалистов в области физики и астрономии. Базовые дисциплины включают разделы общей физики, математики, профессионально-ориентированного языка, дополнительные главы высшей математики и определяют подготовку специалистов, знающих и способных применять основной математический и физический аппарат для дальнейших исследований в области физики и астрономии. Профилирующие дисциплины включают общую астрономию, астрометрию, основы астрофизики, небесную механику, радиоастрономию и дают основу для подготовки высококвалифицированных специалистов в области фундаментальной физики и астрономии. Дальнейшие дополнительные виды обучения в форме учебной и производственной, педагогической и преддипломной практики и итоговая аттестация в виде государственного экзамена по специальности и написание и защита дипломной работы предполагает выпуск высококвалифицированных специалистов в области физики и астрономии. Тип образовательной программы – бакалавр. Сроки освоения программы – 4 академических года. Продолжительность одного академического года – 2 семестра по 15 недель. Форма обучения – очная. Трудоемкость в зачетных единицах – 153 кредита.

Оценка образовательной программы и рекомендации.

Студенты изучают образовательные модули и дисциплины, направленные на методы исследования теоретических и экспериментальных данных, обработку данных, такие как «Компьютерное моделирование в физике», «Спектральные методы исследования планет», «Небесная механика», «Основы астрофотометрии», «Информационно-энтропийный анализ астрофизических сигналов», «Космическая радиолокация и радионавигация», которые дают основы знаний и навыков обработки астрономических данных

и методы анализа и расчета физических процессов. Ряд образовательных модулей и дисциплин направлены на теоретические знания общей физики, астрономии, что дает возможность преподавать физику и астрономию в средних и высших учебных заведениях, быть востребованными в научно-исследовательских институтах, лабораториях, научных центрах. В процессе обучения студенты могут участвовать непосредственно в астрономических наблюдениях. Также студенты участвуют в исследовательских работах и могут представлять свои работы в республиканских конкурсах среди студентов и молодых ученых.

Рекомендуем увеличить практические занятия, связанные с обработкой и интерпретацией астрономических данных для подготовки специалистов в области физики и астрономии.

В целом образовательная программа «Физика и Астрономия» по специальности 5В061100- «Физика и астрономия» КазНУ имени аль-Фараби соответствует требованиям, предъявляемым к квалификации выпускника.

Доктор физ.-мат наук, профессор,
КазНУ им. К.И.Сатпаева



Беков А.А.

Max-Planck-Institut für Astronomie

Christian Fendt

Prof. apl. Dr. rer. nat.

Max-Planck-Institut für Astronomie ** Königstuhl 17 ** D-69117 Heidelberg ** Email: fendt@mpia.de



To whom it may concern

Ref.:

Heidelberg, November 23, 2018

**Comments to the educational program
Astrophysics and Observational Astronomy,
the specialty 5061100 Physics and Astronomy
of Al-Farabi Kazakh National University**

Based on the discussion with the developers of the program Dr. Margulan Ibraimov and Dr. Serik Khokhlov and quick review of the KEY (WORKING) EDUCATIONAL PLAN FOR SPECIALTIES 5061100 PHYSICS AND ASTRONOMY I have the following recommendations.

1) I would recommend to shorten significantly the GENERAL EDUCATION DISCIPLINES (GED) and allow the students to dedicate more time to the fundamental physical subjects. I believe that 29 credits out of 130 for the all theoretical studies (that is more than 20

2) I also would recommend to include the preparation and the defense of the Bachelor thesis, that will give students a first experience in the scientific research and help to find the first scientific supervisors and collaborators. When the students apply for future positions (MSc or PhD), their research experience is the most important selection criterion.

3) It is also essential to offer practical courses, that will provide necessary skills in programming or data reduction. A basic understanding of the numerical tools is required for any project in astronomy or astrophysics. Examples are tools for data mining and analysis, machine learning, scientifically oriented programming languages (like Python, IDL, C, Fortran, etc.). This will put students also in a much better position when they look for a job outside academia, for example as a data scientist.

4) Another part of the education program should be seminars or journal clubs where students can practice scientific presentations and - even in a BSc program - will come in contact with scientific publications. Again this is a suggestion concerning practicing - instead of attending a lecture on a foreign language (most probably English), they better practice English in a seminar talk. Having a colloquium series with invited speakers from international destination would help students also to communicate with research colleagues early on.

In general the educational program contains most of core disciplines required for a Bachelor degree of Astronomy. Note, however, that in many countries students study first physics as a major, finishing with a BSc in physics, and only then enter an astronomy program.

With best regards,

Christian Fendt

**«ҰЛТТЫҚ ҒАРЫШТЫҚ ЗЕРТТЕУЛЕР МЕН
ТЕХНОЛОГИЯЛАР ОРТАЛЫҒЫ»
АКЦИОНЕРЛІК ҚОҒАМЫ**

**«В.Г.ФЕСЕНКОВ атындағы
АСТРОФИЗИКАЛЫҚ ИНСТИТУТ»
ЕНШІЛЕС ЖАУАПҚЕРШІЛІГІ
ШЕКТЕУЛІ СЕРІКТЕСТІГІ**



**АКЦИОНЕРНОЕ ОБЩЕСТВО
«НАЦИОНАЛЬНЫЙ ЦЕНТР КОСМИЧЕСКИХ
ИССЛЕДОВАНИЙ И ТЕХНОЛОГИЙ»**

**ДОЧЕРНЕЕ ТОВАРИЩЕСТВО
С ОГРАНИЧЕННОЙ ОТВЕТСТВЕННОСТЬЮ
«АСТРОФИЗИЧЕСКИЙ ИНСТИТУТ
ИМ. В.Г. ФЕСЕНКОВА»**

050020, Алматы қ., Каменское плато, Обсерватория 23
тел./факс.: 8 (727) 260-75-90, e-mail: secretariat@aphi.kz

050020, г. Алматы, Каменское плато, Обсерватория 23
тел./факс.: 8 (727) 260-75-90, e-mail: secretariat@aphi.kz

12.12.2018 № 02-10-02/233

**Экспертное заключение
на образовательную программу
«Astrophysics and Observational Astronomy» на английском языке по
специальности 5B061100 – «Физика и астрономия»
Казахского национального университета им. аль-Фараби**

Общая характеристика образовательной программы.

Настоящая образовательная программа нацелена на подготовку высококвалифицированных специалистов в области физики, астрономии, астрофизики и космологии: знающих наиболее известные основные теории и модели астрономических явлений и процессов, возможности их практического приложения; знающих и умеющих применять основные экспериментальные, теоретические и численные методы исследования астрономических явлений и процессов, физических свойств и характеристик космических объектов и излучений; способных к обработке полученных результатов научных исследований и их анализу с использованием новых компьютерных технологий; проведению уроков физики и астрономии в средних общеобразовательных и специальных учебных заведениях с использованием новых методов и технологий обучения. Также программа нацелена на подготовку высококвалифицированных специалистов в области физики и астрономии обладающих фундаментальными знаниями, базирующимися на прочной экспериментальной и теоретической основе, новейших достижениях науки, обладающих навыками и умениями для проведения научных исследований в области астрофизики и космологии, востребованными в научно-исследовательских институтах, научных центрах, конструкторских и проектных бюро, учреждениях образования и органах государственного управления соответствующего профиля. Задачи программы – дать студентам широкие фундаментальные знания и компетенции, необходимые для работы в научно-исследовательских институтах, лабораториях, конструкторских и проектных бюро и фирмах, учреждениях среднего и специального образования, государственных и негосударственных учреждениях соответствующего профиля, инициативных, способных к

3178

адаптации при меняющихся требованиях рынка труда и технологий, умеющих работать в команде. Тип образовательной программы – бакалавр. Сроки освоения программы – 4 академических года. Продолжительность одного академического года – 2 семестра по 15 недель. Формы обучения – очная. Трудоемкость в зачетных единицах – 153 кредитов.

Оценка образовательной программы и рекомендации.

Студенты бакалавриата участвуют непосредственно в астрономических наблюдениях, имеют возможности на внеклассные, полевые экспедиции тем самым могут закрепить теоретические знания на практике. Также участвуют в исследовательских работах, тем самым могут представлять свои творческие работы в республиканских конкурсах среди студентов и молодых ученых. Студенты изучают образовательные модули и дисциплины, связанные с обработкой данных, как «Математические методы обработки информации (данных)», «Информационно-энтропийный анализ астрофизических сигналов», «Основы векторно-тензорного анализа», «Компьютерное моделирование физических процессов», «Спектральные методы исследования планет», «Небесная механика», «Основы астрофотометрии», которые формируют базовые навыки для обработки астрофизических данных и базовые знания методов анализа и расчетов для описания процессов. Кроме этого имеются ряд спецкурсов, направленные на теоретические и практические знания астрономии, астрофизики и общей физики, что дает возможность выпускникам данной специальности преподавать в средних и высших учебных заведениях.

Рекомендуем увеличить практические курсы, направленные на исследование, обработку и анализ астрофизических данных для подготовки специалистов-исследователей в области фундаментальной физики и астрономии.

В целом образовательная программа «Astrophysics and Observational Astronomy» на английском языке специальности «5B061100 – Физика и астрономия» КазНУ имени аль-Фараби соответствует требованиям, предъявляемым к квалификации выпускника.

Заместитель директора
по научно-исследовательской
работе, к.ф.-м.н.
ДТОО «Астрофизический
институт имени В.Г. Фесенкова»

Подпись заверяю инспектор по кадрам



Валиуллин Р.Р.

З. Агафонова



28/11/2018 N 319

**Экспертное заключение
на образовательную учебную программу по
специальности «5В061100 – Физика и астрономия»**

Представленная образовательная программа нацелена на подготовку бакалавров естествознания по специальности. Курс состоит из 153 кредитов осваиваемых в течении 8 семестров на протяжении 4 лет обучения по 43, 42, 39 и 29 кредитов соответственно. Обучение является модульным и содержит как обязательные компоненты, так и компоненты по выбору. В разрезе курса по содержанию, картина складывается следующим образом:

Теоретическое образование – 130 кредитов

Общеобразовательные дисциплины – 29 кредитов

Обязательный компонент – 21 кредит

- Социально-гуманитарный модуль – 6 кредитов
- Инструментальный модуль – 15 кредитов

Компонент по выбору – 8 кредитов

- Финансово-правовой модуль – 4 кредита
- Культурно-коммуникативный модуль -4 кредита
- Общественно-политический модуль – 4 кредита
- Экологический модуль – 4 кредита
- Предпринимательский модуль – 4 кредита
- Экономико-правовой модуль – 4 кредита
- Историко-культурный модуль – 4 кредита
- Социально-политические и исторические основы современного общества – 4 кредита
- Глобальные вызовы современной экономики – 4 кредита

Базовые дисциплины – 69 кредитов

Обязательный компонент – 20 кредитов

- Общая физика 1 – 10 кредитов
- Инновационные методы в преподавании – 6 кредитов
- Профессиональный язык – 4 кредита

Компонент по выбору – 49 кредитов

- STEM-модуль – 7 кредитов
- Физика звезд – 8 кредитов
- Общая физика 2 – 8 кредитов
- Общая физика 3 и Педагогика – 8 кредитов
- Практикум по общей физике – 8 кредитов
- Теоретическая физика – 6 кредитов
- Дополнительные главы высшей математики – 4 кредита

Профилирующие дисциплины – 32 кредита

Обязательный компонент – 5 кредитов

- Общая астрономия – 5 кредитов

Компонент по выбору – 27 кредитов

- Астрофизика- 9 кредитов
- Звездная астрономия – 9 кредитов
- Физика планетных систем – 9 кредитов
- Наблюдательная астрономия – 9 кредитов
- Радиоастрономия – 9 кредитов
- Космические лучи – 9 кредитов

Дополнительные виды обучения – 23 кредита

- Физическая культура – 8 кредитов

Модуль профессиональной практики – 12 кредитов

- Учебная практика – 2 кредита
- Производственная практика – 4 кредита
- Педагогическая практика – 4 кредита
- Преддипломная практика – 2 кредита

Итоговая аттестация – 3 кредита

- Государственный экзамен по специальности – 1 кредит
- Написание и защита дипломной работы (проекта) – 2 кредита

Модульная система обучения, где каждый может независимо выбирать содержание индивидуальных учебных программ является максимально гибким и соответствует современным требованиям образовательной системы. Возможность выбирать компоненты самостоятельно студентами дает возможность для каждого обучаться интересующим знаниям и умениям и развиваться индивидуально.

Вышеописанная возможность еще более актуальнее в рамках данной программы, так как она предназначена на подготовку выпускников широкого профиля. Это студенты, имеющие квалификацию как в фундаментальной физике, так и в астрономии, как ее ответвления. Наличие педагогической практики, модулей иностранного и профессионального языков, культурно-коммуникативного и методов в преподавании открывает карьерные возможности для выпускников в образовательной деятельности. Это преподаватели физики в школах и специализированных образовательных учреждениях на трех языках,

казахском, английском и русском. Наличие модулей по общей и фундаментальной физике открывает молодым специалистам карьерные возможности в научных и научно-исследовательских учреждениях в качестве научных сотрудников. Производственная практика и практикумы по общей физике также полезны и для будущих инженеров и операторов оборудования. В число таких организаций можно причислить 3 обсерватории Астрономической обсерватории им. Фесенкова (АФИФ) и в обсерватории национального научно-практического, образовательного и оздоровительного центра «Бобек» только в самой Алмате, не учитывая десятки специализированных планетариев по республике, например, в городах Актобе и Павлодар.

Английский язык и образовательная программа, построенная аналогично международным стандартам и содержащие одноименные курсы, дает выпускникам возможность трудоустройства по специальности за рубежом или же дальнейшего обучения в магистратуре и докторантуре без существенных препятствий. С этой точки зрения, можно утверждать, что образовательная учебная программа по специальности «5В061100 – Физика и астрономия» соответствует зарубежным аналогам и по содержанию и названию читаемых дисциплин. Это безусловное, конкурентное преимущество наших выпускников и на международной арене.

Подробный анализ в разрезе слайбусов и конкретных модулей показывает строгую, логическую связанность и последовательность структуры дисциплин, а читаемый материал по каждому из них является актуальным и свежим. В каждом отдельном читаемом блоке компонентов по выбору, например: Астрофизика, Звездная астрономия, Наблюдательная астрономия, Радиоастрономия, Космические лучи – выделяется значительное количество времени для обучения основам компьютерных методов в каждой из этих дисциплин, и на мой, личный взгляд, не акцентируются методы оценки погрешностей и измерения инструментальных ошибок в каждом отдельном блоке.

Поэтому я рекомендую добавить дополнительный блок по основам компьютерной техники в астрономии и астрофизике, где студенты могли бы обучаться работе на компьютерах под управлением различных операционных систем. Иметь базовые навыки по скачиванию, установке и интеграции различных астрономических пакетов в эти системы. Приобрести умения работать с командной строкой и при отсутствии привычного, на windows, графического пользовательского интерфейса. Знать основные команды и понимать принципы работы таких систем. В первую очередь это связано с широкой распространённостью такого подхода в научной среде и повсеместного использования в системах управления телескопами и другим научными приборами. В качестве конкретного примера приведу работу в операционной системе Linux и на языке программирования AstroPy (производная библиотека для языка программирования - Python).

Анализ поступивших студентов на специальность «Физика и астрономия» прошлых лет показывает наличие большого процента ребят с сельской местности и других городов чем Астана и Алматы. На мой взгляд это хорошая возможность для обеспечения базы практики этих студентов по месту прибытия для создания эко сферы по обмену знаний и навыков между крупным учебным центром как

КазНУ и регионами. Во-первых, появляется возможность трансляции геперируемых в университете знаний в регионы быстро. Во-вторых, облегчается задача, связанная с трудоустройством выпускников уже на этапе их обучения в университете путем обеспечения базы стажировки.

В целом, образовательная учебная программа специальности «5В061100 – Физика и астрономия» соответствует требованиям, предъявляемым к образовательным программам и является надежной базой в подготовке высококвалифицированных и конкурентоспособных специалистов этой области.

Учёный секретарь НИИЭТФ,
канд. физ.-мат. наук



А.К. Иманбаева

Декану физико-технического факультета
КазНУ им. аль-Фараби
Давлетову А.Е.

Письмо-подтверждение

Астрометрия, занимающаяся определением положений и движений небесных тел, изучением вращения и формы Земли, а также определением и хранением времени, является одним из основных направлений, чьи результаты широко используются всеми другими разделами астрономии. В связи с этим дисциплина «8В36 Астрометрия» относится к числу наиболее важных дисциплин при подготовке физиков-астрономов и является основой для последующего изучения студентами различных спецкурсов как теоретического, так и наблюдательного циклов.

Цели и ожидаемые результаты изучения дисциплины «Астрометрия» были определены совместно со специалистами в области проведения позиционных наблюдений небесных тел и обработки результатов этих наблюдений нашего института.

Сyllabus дисциплины полностью охватывает основные вопросы курса, включая такие ключевые разделы, как: Пространственно-временные системы координат в астрометрии, фигура и вращение Земли, системы счета и хранение времени, эффекты, искажающие положение светил на небесной сфере, методы и инструменты практической астрономии и фундаментальной астрометрии, метод радиоинтерферометрии со сверхдлинными базами (РСДБ) в астрометрии.

Таким образом, syllabus дисциплины «8В36 Астрометрия» соответствует требованиям подготовки выпускников по специальности «5В061100 – Физика и астрономия».

Президент АО «НЦКИТ»
канд. физ.-мат. наук



Омаров Ч.Т.

Декану физико-технического факультета

д.ф.-м.н., проф. Давлетову А.Е.

Письмо-подтверждение

На современном этапе развития науки необходимы более содержательные учебные программы, отражающие актуальные направления и тенденции в изучении радиофизики и электроники.

В настоящем учебном курсе по дисциплине «Основы радиофизики и электроники», составленном для специальности «5В061100 - Физика и астрономия», отражен необходимый минимум вопросов по изучению студентами элементной базы радиоэлектронных устройств, принципов действия аналоговых и цифровых устройств, начиная с простых и заканчивая сложными многофункциональными устройствами.

В разработанной программе учтено современное состояние и перспективы развития электронной техники. В ней приведены вопросы по изучению основных классов электронных приборов, физических процессов в электрических цепях, характеристик и параметров простейших полупроводниковых схем, интегральных схем и элементов цифровой техники. Содержание и последовательность изложения поставленных вопросов должно облегчить усвоение студентами курса радиоэлектроники и сформировать навыки работ с радиоэлектронной аппаратурой. Рассмотрены вопросы передачи информации, анализируются структурные схемы основных радиоэлектронных устройств. Отражены вопросы передачи сигнала радиоэлектронными цепями, построения простейших полупроводниковых схем, схемотехники отдельных устройств на базе дискретных радиокомпонентов, особенности интегральных схем.

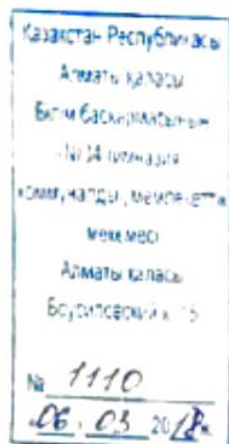
По дисциплине предусматривается лекционные, семинарские и лабораторные занятия. Рекомендуемый список литературы включает основные учебные пособия и современные работы.

Силлабус по дисциплине «Основы радиофизики и электроники» соответствует профессиональной подготовке выпускников по специальности «5В061100 - Физика и астрономия».

Президент АО «Национальный центр космических
исследований и технологий», к.ф.-м.н.



/Омаров Ч.Т.



Декану физико-технического факультета
КазНУ имени аль-Фараби
Давлетову А.Е.

ПИСЬМО-ПОДТВЕРЖДЕНИЕ

Физика и астрономия в среднем образовании незаменимы в процессе формирования мировоззрения обучающихся и создании современной научной картины мира. Физика тесно связана с техникой и производством

Целью курса «Теория и методика обучения физике и астрономии» является подготовка студентов в процессе обучения в вузе к выполнению профессионально-педагогической деятельности преподавателя физики и астрономии. В результате обучения студент будет способен понимать цели обучения физике и астрономии в учреждениях среднего и высшего образования, понимать содержание курсов физики и астрономии средней и высшей школы, применять пособия, входящие в учебно-методические комплекты по физике и астрономии, анализировать методы обучения физике и астрономии, применять формы организации учебных занятий по физике и астрономии; анализировать типы уроков по физике; применять современные технологии обучения физике и астрономии, включая информационные и коммуникационные; определять направления дальнейшего личностного и профессионального развития

Силлабус по дисциплине «Теория и методика обучения физике и астрономии» соответствует профессиональной подготовке выпускников по специальности «5В061100 – Физика и астрономия».

Директор Гимназии №34



Бейсенбаева З.Т.

Evaluation of the educational curriculum for the specialty
"5B061100 - Physics and Astronomy"
of the Al-Farabi Kazakh National University.

The educational curriculum for the specialty "5B061100 - Physics and Astronomy" is intended for the preparation of Bachelor of Natural Sciences on a specialty. This educational program covers theoretical and practical issues of modern astronomy and astrophysics, courses in cosmology and theoretical physics, the basics of physical education, such as mechanics, molecular physics, electricity and magnetism.

The course is aimed at the formation of cultural, professional and special competences, knowledge and skills in the field of physics and astronomy. The main curriculum of the educational program contains actual theoretical and practically relevant material, supported by skills acquired in laboratory work.

Educational curriculum is modular and flexible. It's one of advantages for further professional growth of each individual. Knowledge of fundamental physics provides opportunities for students to build successful professional, research and engineering career. The presence of computer skills will allow future graduates to work in the field of analysis processing and modeling of physical processes. The topics presented in the syllabuses of the "Physics and Astronomy" educational program that are being implemented contain the main ideas and concepts of the course and contribute to the acquisition of basic knowledge and skills for further professional use.

Main attention is paid to working with software and packages related to data processing and analysis. It is included photometric and spectral data in the multiwave range as radio, optical and infrared range. The student gains skills in the basics of working with databases of astronomical and astrophysical data. A number of laboratory works on the above topics are envisaged, as well as homework assignments by the students themselves.

The curricula on the basics of modern cosmology reflect quite well the modern achievements in science. However, the expansion of this course or the addition of an educational program with a new course related to the problems of gravitational-wave astronomy would make the program more relevant to modern trends in the development of the science industry. This can be an important factor in improving the quality of educational program, since the direct detection of gravitational waves makes this area

very popular at the turn of the decades. This direction is predicted by the rapid and dynamic growth and high interest of the scientific community in the development of this topic and promises great discoveries. Moreover, due to the rapid development of gravitational-wave telescopes over the past, cosmology has evolved from pure theoretical physics into the science of observations.

This recommendation is significant and implementable for the reason that the main mathematical approaches to understanding this course are already being studied by students in non-linear physics module. Methods of analysis and signal processing are given in practical astronomy courses. And knowledge of the methods of informational entropy and fractal analysis given at this course are advantages over other universities.

Thus, the program "Physics and Astronomy" satisfies all the requirements for a bachelor degree in the field of physical and astronomical sciences. Study programs are consistent with other similar programs at large, foreign universities around the world. The presented educational program for the specialty "5B061100 - Physics and Astronomy" meets the requirements for graduate qualifications, provides comprehensive training for students, forms cultural, ethical and professional competences, is relevant and significant in the preparation of graduates.

Teacher of physics,
AO "Nazarbayev Intellectual Schools"
NIS ChB Almaty



Sandybayev Y.

**Экспертное заключение
на образовательную программу по специальности
«5B061100 – Физика и астрономия»**

На основе предоставленного материала: учебного плана, учебной программы, syllabusов и учебно-методических комплексов дисциплин

Образовательная программа разработана на основе Типового учебного плана специальности 5B061100 – Физика и астрономия (от 23 августа 2012 года с изменениями от 13 мая 2016 года) в соответствии с международными требованиями в сфере высшего образования: рекомендация программы ECTS и «Tuning Educational Structures in Europe», и устанавливает требования к содержанию образования через результаты обучения, объему учебной нагрузки и уровню профессиональной подготовки бакалавров. Образовательная программа разработана с учетом сопоставления трудоемкости учебной нагрузки в соответствии с требованиями Болонской декларации.

В целом, образовательная, учебная программа по специальности «5B061100 – Физика и астрономия» направлена на подготовку бакалавров в течение 8 семестров обучения в университете и является модульной. Первые 3 семестра направлены на укрепление базовых знаний по общей физике и математике, а также содержат курсы социально гуманитарного характера. Это дисциплины по экономике, праву, истории и языкам. Оставшиеся 5 семестров, на старших курсах, направлены на приобретение студентами специализированных знаний. Это курсы по общей физике, астрономии и астрофизике. Учебной программой предусмотрено закрепление полученного, теоретического знания на практических, лабораторных занятиях, а также применений полученных умений на решении практических задач, во время производственной, педагогической и преддипломной практик. Данный подход действительно способствует развитию специальных навыков у выпускников, на выходе образовательной программы.

В целом программа нацелена на подготовку кадров для научно исследовательской и преподавательской деятельности. Выпускники имеют прочные знания пригодные для ведения образовательной и исследовательской деятельности сразу по завершению обучения. Помимо этого, знания, приобретенные в рамках социально гуманитарных программ – дают дополнительную ориентированность и степени свободы для ведения смежной деятельности.

Сильными сторонами учебной программы является подготовка кадров ведущейся на английском языке и возможность студентов самостоятельно выбирать интересующие дисциплины. Особого внимания заслуживает логическая последовательность в структуре программы и возможности ее модульной совместимости. Курсы, предложенные в рамках рассматриваемой

программы, имеют аналоги в ведущих, зарубежных ВУЗах и исследовательских центрах, где обучение также ведется и на английском языке. В свою очередь это несет потенциал для зарубежного сотрудничества и делает простым процесс обмена студентами.

Соответствие профильных предметов зарубежным аналогам, а также соответствие структуры курса требованиям МОН РК делают возможным дальнейшее обучения выпускников бакалавриата в магистратуре и докторантуре PhD, как в нашей стране, так и за ее пределами. В рамках вышесказанного, рекомендую укрепить международные связи с университетами и исследовательскими центрами ведущие перспективные исследования по специальности для обмена студентами и обеспечения производственных и преддипломных стажировок студентов на базе этих центров.

Так как главной задачей университета, на мой взгляд, является подготовка кадров, способных быть конкурентоспособными на рынке труда, рекомендую расширить сотрудничество университета с местными и региональными производителями и дистрибьюторами астрофизического, исследовательского оборудования. Расширить базу производственных практик в сотрудничестве с такими организациями.

На мой взгляд, ниша астрономического образования и популяризация этой науки для широкого общества может быть интересным и нести познавательный характер. Данное направление несет большой потенциал для старт-ап проектов студентов. Наличие бизнес-инкубаторов при университетах, а также множество грантов для молодежных исследовательских и инициативных проектов выделяемых при сотрудничестве с государственными и бюджетными организациями типа планетария во дворце школьников или обсерватории при центре «Бобек» могут быть простимулированы дополнительно. Хотя такие проекты не связаны с образовательной программой напрямую, акцент на подобную деятельность помог бы быть выпускникам программы соответствовать реалиям рынка.

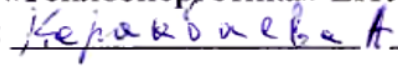
В целом, считаю образовательную, учебную программу специальности «5B061100 – Физика и астрономия» соответствующей требованиям, предъявляемым к документам такого рода. Программа, в ее текущей редакции может служить для подготовки конкурентоспособных и квалифицированных специалистов для рынка труда.

Экспертизу провел

д.т.н., Член ННС от НПП «Атамекен»  Тайбасаров Ж. К.

Подпись профессора Тайбасарова Ж.К.

кафедры «Теплоэнергетика» ЕНУ им. Л.Н. Гумилева,

заверяю:  /



**Выписка из протокола № 1
заседания учебно-методического объединения
Республиканского учебно-методического совета
высшего и послевузовского образования
на базе КазНУ им. аль-Фараби (далее УМО РУМС)
от 20 ноября 2018 г**

ПРИСУТСТВОВАЛИ: Зам. председателя УМО РУМС на базе КазНУ им. аль-Фараби, проректор по учебной работе Хикметов А.К., ученый секретарь УМО РУМС Сыргакбаева А.С., разработчики образовательной программы «Физика и астрономия».

СЛУШАЛИ:

- **Зам. председателя УМО РУМС на базе КазНУ им. аль-Фараби, проректора по учебной работе Хикметова А.К.:** В 2018 гг. в соответствии с договором № 183 от 14.05.2018 года КазНУ им. аль-Фараби было поручено разработать 10 образовательных программ на английском языке (далее ОП), в их числе ОП «Физика и астрономия». Слово предоставляется декану физико-технического факультета КазНУ им. аль-Фараби, д.ф.-м.н., профессору Давлетову А.Е.

- **Давлетов А.Е.:** ОП «Физика и астрономия» была разработана в рамках выполнения пункта 133 Плана мероприятий по реализации Государственной программы развития образования и науки Республики Казахстан на 2016-2019 годы, в соответствии с Законом Республики Казахстан «Об образовании» от 27 июля 2007 года № 319-III, нормативно-правовыми актами МОН РК, с технической спецификацией по разработке образовательных программ на английском языке. В период разработки программы в МОН РК было отправлено 2 промежуточных отчета и drafts ОП – 1 июля 2018 г., 1 октября 2018 г. Все дисциплины и модули ОП были согласованы с ведущими отечественными и зарубежными учеными и экспертами, а также работодателями.

Слово предоставляется координатору ОП «Физика и астрономия» доктору PhD Ибраимову М.К.

Ибраимов М.К.: В полном соответствии с требованиями технической спецификации для разработки ОП «Физика и астрономия» были привлечены ведущие отечественные и зарубежные специалисты, владеющие английским языком и опытом работы в сфере высшего образования: Ибраимов М.К., Жанабаев З.Ж., Изтлеуов Н.Т., Наурызбаева А.Ж., Хохлов С.А., Каламбай М.Т., Куратов К.С., Агишев А.Т., Кайраткызы Д., Майлыбаев А.Т., Dr. Miroshnichenko Anatoly - University of North Carolina at Greensboro, North Carolina, United States Professor of Dept. Physics & Astronomy. Dr. Jarken Esimbek – Xinjiang Astronomical Observatory, CAS, Urumqi, Xinjiang, China, Deputy Director of XAO, CAS. Dr. Zaks Michael - Humboldt University of Berlin,

Germany (Humboldt-Universität zu Berlin), Professor of Department of Physics
Dr. Quevedo Hernando - National Autonomous University of Mexico, Mexico City,
Mexico (Universidad Nacional Autónoma de México). Dr. Zharikov Sergey -
National Autonomous University of Mexico, Mexico City, Mexico (Universidad
Nacional Autónoma de México). Отечественные учебные заведения: Беков А.А.
- д.ф.-м.н., профессор КазНУ им. К. И. Сатпаева. Турмухамбетов А.Ж. –
д.ф.-м.н., профессор КазНУ им. К. И. Сатпаева. Представители
работодателей: Чечин Л.М. – профессор, д.ф.-м.н. ДТОО «АФИФ»
(Астрофизический институт им.Фесенкова). Сомиков В.М. –д.ф.-м.н.,
профессор ДТОО Институт ионосферы. Валиуллин Р.Р.- к.ф.-м.н.,
заместитель директора по научно-исследовательской работе АО «НЦКИТ».
Иманбаева А.К. - к.ф.-м.н., ученый секретарь, ДГП на ПХВ «НИИЭТФ». Во
время командировки были ознакомлены с учебными программами
университетов Германии по специальности «Физика и астрономия», а также с
деятельностью Max-Planck-Institut für Astronomie для дальнейшего
сотрудничества.

Хикметов А.К.: ОП «Физика и астрономия» разработана в
соответствии с требованиями технической спецификации, структура и
содержание ОП согласованы с работодателями, сроки выполнения работ
соблюдены. Предлагаю одобрить ОП на английском языке «Физика и
астрономия». Прошу коллег высказать свое мнение. Принято единогласно.

ПОСТАНОВИЛИ:

Одобрить образовательную программу на английском языке «Физика и
астрономия».

**Зам. председателя УМО РУМС
на базе КазНУ им. аль-Фараби,
проректор по учебной работе**

А.К. Хикметов

**Декан физико-технического
факультета, д.ф.-м.н., профессор**

А.Е. Давлетов

Ученый секретарь УМО РУМС

А.С. Сыргакбаева