**SYLLABUS**

**Fall semester 2023-2024 academic years**

**on the educational program “8D05308 - nuclear physics ”**

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| **Discipline’s code** | **Discipline’s title** | **Independent work of students (IWS)** | **Number of credits** | | | | | **Number of credits** | **Independent work of student with teacher (IWST)** |
| **Lectures (L)** | **Practical training (PT)** | | **Laboratory (Lab)** | |
| **EFVE 7301** | Experimental high-energy physics | 98 | 15 | 30 | | 0 | | 5 | 7 |
| **Academic course information** | | | | | | | | | |
| **Form of education** | **Type of course** | **Types of lectures** | | | **Types of practical training** | | **Form of final control** | | |
| Full-time |  |  | | |  | |
| Lecturer | Burtebaev Nasurla, Ph.D., Professor | | | | | | written | | |
| e-mail | nburtebayev@yandex.ru | | | | | |
| Telephone number | +77772221670 | | | | | |

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| **Aim of course** | **Expected Learning Outcomes (LO)\***  As a result of studying the discipline the undergraduate will be able to: | **Indicators of LO achievement (ID)**  (for each LO at least 2 indicators) |
|  | 1. Apply experimental skills to conduct a physical experiment. To carry out calculations of the processes of experimental high-energy physics. | 1.1. apply knowledge about radiation interactions and detector operating principles to select the most appropriate type of detector for a specific detection task.  1.2. to interpret the properties of the most common types of materials for detectors, the principles of operation of detectors based on these materials and their characteristic properties in terms of energy resolution, efficiency and time. |
| 2. Critically analyze existing concepts, theories and approaches to the analysis of processes of experimental high-energy physics; | 2.1. describe the structure of the cores according to various models  2.2. describe the mechanisms of interaction of nuclear radiation with matter |
| 3. Possess methods of setting and solving problems related to experimental high-energy physics; | 3.1. choose the experimental method that is best suited for measuring the structure of nuclei or the mechanism of nuclear interaction  3.2. apply knowledge about radiation interactions and detector operating principles to select the most appropriate type of detector for a specific detection task. |
| 4. Formulate original, complex arguments (proofs) reflecting a critical analysis of methods and attitudes; | 4.1. interpret the processes occurring during the interaction of ions, heavy charged particles, gamma quanta and neutrons with matter.  4.2. conduct nuclear physics experiments using modern experimental methods of nuclear physics. |
| 5. Evaluate, select and justify methodological approaches and research methods that meet the goals and objectives of experimental high-energy physics. | 5.1. to evaluate the reliability of the expected results of the experiment with the use of experimental methods and world literature data.  5.2. choose the experimental method that is best suited for measuring the structure of nuclei or the mechanism of nuclear interaction. |
| **Prerequisites** | To understand this special course, students must know nuclear physics in the scope of the general course, have an idea of natural and artificial sources of ionizing radiation (AI). | |
| **Post requisites** | High energy physics and elementary particles. | |
| **Information resources\*\*** | **Literature:\*\***  1. Фраунфельдер Г., Хенли Э. Субатомная физика. М.- Мир. 1979.  2. Блан Д. Ядра, частицы, ядерные реакторы. М.- Мир. 1989.  3. Готтфрид К., Вайскопф В. Концепции физики элементарных частиц. М.- Мир. 1988.  4. Ядерная Астрофизика. Под редакцией Ч.Барнса, Д.Клейтона, Д.Шрамма. - М.: Мир, 1986.  5. Краморовский Я.М., Чечев В.П. Синтез элементов во Вселенной М.: Наука , 1987  6. Бисноватый-Коган Г.С. Эволюция звезд. Физическая энциклопедия Т.5.С.487. М.: Большая Российская энциклопедия, 1998  7. Бопп Ф. Введение в физику ядра, адронов и элементарных частиц. М.- Мир. 1999.  Дополнительная  1. Л.В.Окунь. Введение в физику элементарных частиц. -М.: Наука, 1988.  2. В.С. Мурзин, Л.И.Сарычева. Физика адронных процессов. -М.: Энсргоатомиздат, 1986.  3. В.С. Мурзин, Л.И.Сарычева. Взаимодействия адронов высоких энергий. -М.: Наука, 1983.  4. Т.П. Аминева, Л.И. Сарычева. Фундаментальные взаимодействия и космические лучи. -М.: Эдиториал УРСС, 1999.  5. Л.И. Сарычева. Лекции, весна 2007.  6. И.П. Лохтин, Л.И.Сарычева, А.М.Снигирев. Сб. ЭЧАЯ, т. 30, вып. 3, с. 660-719, 1999. − Диагностика сверхплотной материи в ультрарелятивистских столкновениях ядер.  Интернет-ресурсы  1. http://nuclphys.sinp.msu.ru/elp/index.html  2. http://www1.jinr.ru/Books/sisakian/Sisakian03.pdf  3. https://elementy.ru/LHC | |

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| **Academic policy of the course in the context of university moral and ethical values** | **AcademicBehaviorRules:**  Rules of academic conduct:  Mandatory attendance at classes, the inadmissibility of tardiness. Absence and lateness to classes without prior warning of the teacher are estimated at 0 points.  Mandatory compliance with deadlines for the completion and delivery of tasks (on SRS, milestone, control, laboratory, project, etc.), projects, exams. In case of violation of deadlines, the completed task is evaluated taking into account the deduction of penalty points.  Attention! Failure to meet deadlines leads to the loss of points! The deadline for each task is indicated in the calendar (schedule) of the implementation of the content of the training course, as well as in the MOOC.  Academic values:  Academic honesty and integrity: independence of performing all CPC tasks, including seminars; inadmissibility of plagiarism, forgery, use of cheat sheets, cheating at all stages of knowledge control, deceiving the teacher and disrespectful attitude towards him. (KazNU Student Honor Code)  Students with disabilities can receive counseling at the following email addresses and phone numbers:  Department nburtebayev@yandex.ru +7777221670  Lecturer nburtebayev@yandex.ru +7777221670 |
| **Evaluation and attestation policy** | **Criteria-basedevaluation:**  evaluation of learning outcomes in relation to descriptors (checking the formation of competencies at the boundary control and exams).  **Summative assessment:** assessment of the activity of the work in the audience (at the webinar); assessment of the completed task.  The formula for calculating the final score.  Final score = (RC1+RC(MT)+RC2)/3\*0,6+0,4 IR (where RC is Boundary control, MT is midterm, IR is final control)  According to the ratio below   |  |  |  |  | | --- | --- | --- | --- | | Rating  by letter system | Digital equivalent | Points (% content) | Assessment  according to the traditional system | | А | 4,0 | 95-100 | Great | | А- | 3,67 | 90-94 | | В+ | 3,33 | 85-89 | Well | | В | 3,0 | 80-84 | | В- | 2,67 | 75-79 | | С+ | 2,33 | 70-74 | | С | 2,0 | 65-69 | Satisfactory | | С- | 1,67 | 60-64 | | D+ | 1,33 | 55-59 | | D- | 1,0 | 50-54 | | FX | 0,5 | 25-49 | Unsatisfactory | | F | 0 | 0-24 | |

**CALENDAR (SCHEDULE) THE IMPLEMENTATION OF THE COURSE CONTENT:**

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| --- | --- | --- | --- |
| week | Topic name | Number of hours | Max.  score\*\*\* |
| **Module 1** Fundamentals of high energy physics. | | | |
| 1 | **Lec 1.** Introduction. The purpose and objectives of the discipline. Passage of light ions through the substance. | 1 |  |
| 1 | **Sem 1.** A brief review of the scientific literature on experimental nuclear physics. | 2 | 5 |
| 2 | **Lec2.** LHC. ATLAS detector. The structure of the ATLAS detector. | 1 |  |
| 2 | **Sem 2.** Experimental base of high energy physics. The main physical quantities used in the description of phenomena occurring in the microcosm. | 2 | 15 |
| 3 | **Lec3.** Experimental equipment – accelerator complexes of the LHC. Internal ATLAS detector. ATLAS calorimeters . Muon spectrometer of the ATLAS detector .ATLAS front detectors.The trigger of the ATLAS detector. | 1 |  |
| 3 | **Sem 3.** Heaviside system and its connection with the GHS system. | 2 | 15 |
| 3 | **IWST 1.** Consultation on the implementation of IWS 1. |  |  |
|  | **IWS 1.** Analysis of thermal and current noise in electrical circuits and detectors. |  | 15 |
| 4 | **Lec4.** Trigger characteristics for the initial period of operation of the ATLAS detector. | 1 |  |
| 4 | **Sem 4.** Methods for measuring cross-sections in different types of interactions. | 2 | 15 |
|  | **IWST 2.** Qualitative analysis of the restoration of particle trajectories in wire chambers. |  | 20 |
| 5 | **Lec5.** Reconstruction of the main objects in the ATLAS detector trigger. | 1 |  |
| 5 | **Sem 5.** The method of passing counters. | 2 | 15 |
| **Module 2** Physical fundamentals of the operation of nuclear radiation detectors. | | | |
| 6 | **Lec 6.** Physics of the Standard Model. | 1 |  |
| 6 | **Sem 6.** A method for measuring the total cross section on an accelerator with intersecting beams by the luminosity of the beams. | 2 | 10 |
| 7 | **Lec7.** Top quark In-physics. | 1 |  |
| 7 | **Sem 7.** Measurement of cross-sections of pp interactions on opposing beams using Roman pots. | 2 | 15 |
| 7 | **IWST 3.** Consultation on the implementation of **IWS 3.** |  |  |
| 7 | **IWST 3.** Calculation of the mass resolution of the differential Cherenkov counter at a given angular resolution of the optical system and the DVR. |  | 15 |
|  | **LEVEL CONTROL 1** |  | **100** |
| 8 | **Lec8.** ALICE detector complex. | 1 |  |
| 8 | **Sem 8.** Calculation of the differential cross section of elastic scattering based on the classical deflection angle function. | 2 | 15 |
| 9 | **Lec9.** CMS detector complex (detector). | 1 |  |
| 9 | **Sem 9.** The relationship between the nonmonoenergetics of the beam and the tasks of the experiment. Derivation of the formula for the ionization losses of a particle during propagation in a substance. | 2 | 15 |
| 10 | **Lec 10** LHCb detector complex (Large Hadron Collider beauty experiment). | 1 |  |
| 10 | **Sem 10.** Energy resolution of detectors. Analysis of the kinematics of elastic and inelastic particle scattering. | 2 | 15 |
| 10 | **Consultation on the implementation of IWS 4** |  |  |
| 10 | **IWST 4.** Calculation of the pulse resolution of a magnetic spectrometer at a given thickness of the material of track detectors.) |  | 15 |
| 10 | **МТ (Midterm Exam)** |  | **100** |
| 11 | **Lec 11**  TIGER detector complex. | 1 |  |
| 11 | **Sem 11.** Estimation of the required accuracy of measurement of angles and energies of particles at a given accuracy of measurement of the differential cross section. | 2 | 10 |
| 12 | **Lec 12** Detector complex AMS-02. | 1 |  |
| 12 | **Sem 12.** Contact and non-contact measurement methods. Methods of particle identification: measurement of ionization determination of particle charge, identification by (delta – E –E) method. Measurement of particle velocity by a Cherenkov counter. | 2 | 20 |
| 12 | **Consultation on the implementation of IWS 5.** |  |  |
| 12 | **IWST 5.** Graphical solution of the problem of focusing a beam of charged particles with a pair of quadrupole magnetic lenses). |  | 15 |
| 13 | **Lec 13** Neutrino astronomy. | 1 |  |
| 13 | **Sem 13.** Experiments with neutrinos and planning their practical application. | 2 | 10 |
| 14 | **Lec 14.** Trunk-modular electronics systems and standard blocks: ADC, ADC, overlay selectors, etc. | 1 |  |
| 14 | **Sem 14.** Identification by the time-of-flight method; magnetic spectrometer method. | 2 | 10 |
|  | **IWST 6.** Calculation of the luminosity of colliding beams in the collider and the external target at a given current and beam profile. |  | 20 |
| 15 | **Lec 15** Cosmic rays. The energy spectrum of primary cosmic radiation. | 1 |  |
| 15 | **Sem 15.** A method for measuring cross sections in cosmic rays. | 2 | 15 |
| 15 | **Consultation on the implementation of IWS 6.** |  |  |
| 15 | **IWST 7.** Consultation on examination issues |  |  |
|  | **LEVEL CONTROL 2** |  | **100** |

Dean \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Beissen N.A.**

Head of Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Abishev M.E.**

Lecturer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Burtebayev N.**