National University of Uzbekistan
named after Mirzo Ulugbek
Faculty of Mathematics

# Handbook of modules for the study course Physics, B.Sc.

July 2025

valid for all students enrolled
from WS 2023/24 onwards

# The most important details

| | |
|---|---|
| **Duration:** | 8 semesters full-time |
| **Location:** | Tashkent |
| **Qualification**: | Bachelor of Physics, B.A. |
| **Course start:** | Annually in the Autumn term |
| **Language**: | Uzbek |
| **Preparatory internship:** | During the 8th semester, students of the physics program are expected to complete an 8-week pedagogical internship at secondary schools or academic lyceums. This internship is designed to provide hands-on teaching experience and to strengthen the students' practical skills in physical education. |
| **Internship/ study abroad:** | no |
| **Bachelor thesis:** | During the 7th and 8th semesters, final-year students of the physics program work on their bachelor thesis under academic supervision. The thesis is prepared in accordance with the academic standards of the program and is defended at the end of the 8th semester. |
| **Calculation of workload**: | 1 CP equals 30 hours per semester |
| **Examinations**: | The assessment of students' knowledge is carried out in accordance with the Order of the Minister of Higher and Secondary Specialized Education of the Republic of Uzbekistan "On the Approval of the Regulation on the System of Monitoring and Assessing Students' Knowledge in Higher Educational Institutions"[1], developed under the credit–modular system. |
| **Literature**: | Literature mentioned in the module descriptions are first recommendations and do not replace the syllabus of the module. The module coordinators assume as a rule that the titles specified always refer to the most current version. |
| **Attendance**: | Attendance of all seminars, exercises and lab courses is mandatory. |
| **This programme is accredited by** | ASIIN |

[1] https://lex.uz/uz/docs/3916793

## Inhalt

| Module No./ Modul-Nr. | Subjects / Module | Module Requirements/ Modulvoraus-setzungen | CH/ SWS | Type | | | | | Ex/Prü | | CP* | CH / SWS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L/V | S | E/Ü | LC /Pr | Pro | Graded/ Benotet | Attestation/ Testat | | WT / WS 1 | ST / SS 2 | WT / WS 3 | ST / SS 4 | WT / WS 5 | SS / ST 6 | WS / WT 7 | ST / SS 8 |
| UYTB104 | Modern history of Uzbekistan | | 4 | 2 | 2 | | | | P | | 4 | 4 | | | | | | | |
| FALB104 | Philosophy | | 4 | 2 | 2 | | | | P | | 4 | | 4 | | | | | | |
| URTB104 | Uzbek (Russian) language | | 4 | | | 4 | | | P | | 4 | | 4 | | | | | | |
| XJTB104 | Foreign language | | 4 | | | 4 | | | P | | 4 | 4 | | | | | | | |
| DINB204 | Religious studies | | 4 | 2 | 2 | | | | P | | 4 | | | 4 | | | | | |
| UPPB308 | General pedagogy. Psychology | | 8 | 4 | 4 | | | | P | | 8 | | | | | 4 | 4 | | |
| MEXB106 | Mechanics | | 6 | 4 | | 2 | | | P | | 6 | 6 | | | | | | | |
| MANB112 | Mathematical analysis | | 12 | 4 | | 4 | | | P | | 12 | 6 | 6 | | | | | | |
| AAGB112 | Linear Algebra and Analytic Geometry | | 12 | 4 | | 4 | | | P | | 12 | 6 | 6 | | | | | | |
| FPKB124 | Physics Laboratory Course | | 24 | | | | 4 | | P | | 24 | 4 | 4 | 4 | 4 | 4 | 4 | | |
| MOLB106 | Thermal Physics | | 6 | 4 | | 2 | | | P | | 6 | | 6 | | | | | | |
| FJKB206 | Computer Modeling of Physical Processes | | 6 | 2 | | 2 | | | P | | 6 | | | 6 | | | | | |
| DFTB206 | Differential Equations | | 6 | 2 | | 2 | | | P | | 6 | | | 6 | | | | | |
| ELMB206 | Electricity and Magnetism | | 6 | 4 | | 2 | | | P | | 6 | | | 6 | | | | | |
| OPTB206 | Optics | | 6 | 4 | | 2 | | | P | | 6 | | | | 6 | | | | |
| NZMB206 | Theoretical Mechanics | | 6 | 2 | | 2 | | | P | | 6 | | | | 6 | | | | |
| ATFB306 | Atomic Physics | | 6 | 2 | | 2 | | | P | | 6 | | | | | 6 | | | |
| EDNB306 | Electrodynamics | | 6 | 2 | | 2 | | | P | | 6 | | | | | 6 | | | |
| RADB306 | Fundamentals of Electronics | | 6 | 2 | | | 4 | | P | | 6 | | | | | 6 | | | |
| YADB306 | Nuclear and Elementary Particles Physics | | 6 | 2 | | 2 | | | P | | 6 | | | | | | 6 | | |
| KVMB306 | Quantum Mechanics | | 6 | 3 | | 3 | | | P | | 6 | | | | | | 6 | | |
| FOMB4061 | Methods of Teaching Physics | | 6 | 2 | 2 | | | | P | | 6 | | | | | | | 6 | |
| MMFB406 | Methods of Mathematical Physics | | 6 | 2 | | 2 | | | P | | 6 | | | | | | | 6 | |
| TSFB406 | Statistical Physics | | 6 | 3 | | 3 | | | P | | 6 | | | | | | | 6 | |
| | Elective Subjects | | 40 | 20 | 4 | 10 | 6 | | P | | 40 | | | 4 | 12 | 4 | 8 | 12 | |
| FFAB119 | Qualification Internship | | 19 | | | | | 19 | P | | 19 | | | | 2 | | 2 | | 15 |
| YDAB415 | Final State Certification (Including Bachelor thesis) | | 15 | | | | | 15 | P | | 15 | | | | | | | | 15 |
| | | | | | | | | | | | | | | | | | | | |
| | **total credit hours // Semesterwochenstunden** | | 182 | 87 | 12 | 82 | 1 | 0 | | | | 26 | 26 | 26 | 26 | 26 | 26 | 26 | |
| | | | | | | | | | | | Credit Point | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | | | | | | | | | | | | | | | | 240 | | | |

| | | total | 1.Sem | 2.Sem | 3.Sem | 4.Sem | 5.Sem | 6.Sem | 7.Sem | 8.Sem |
|---|---|---|---|---|---|---|---|---|---|---|
| CH | | 182 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | |
| CP | | 240 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |

**Abbreviations: // Abkürzungen**
CH = credit hours per week // SWS = Semesterwochenstunden
WS = winter term // Wintersemester
SS = summer term // Sommersemester
Ex/Prü = type of examination // Prüfungsart
CP = credit points ( = ECTS-points)
L/V = Lecture // Vorlesung
S = seminar // Seminar
E/Ü = exercise // Übung
LC/Pr = lab course // Praktikum
Pro = project // Projekt
T = certificate // Testat (unbenotet)
P = examination (graded) // benotete Prüfung

*ECTS will only be credited after completing all parts of the module.
ECTS 5arden erst nach vollständigem Ableisten aller Modulteile gutgeschrieben.
** In addition to the General Examination Regulations for Bachelor 's Degree Programmes regarding the admission to the internship or study abroad the student has to show the successful completion of all modules/module examinations of the first study year of the study programme.
Ergänzend zu den Voraussetzungen der Rahmenprüfungsordnung zur Zulassung zum Praxis- oder Auslandsstudiensemester hat der/die Studierende das erfolgreiche Ableisten sämtlicher Module/Modulprüfungen des 1. Studienjahres des Studiengangs nachzuweisen.

| | Elective subjects 1<br>Wahlpflichtkatalog 1 | | WS | Ex | CP |
|---|---|---|---|---|---|
| UK2304 | General Chemistry | | 4 | P | 4 |
| KA2304 | Fundamentals of Chemistry | | 4 | P | 4 |
| | **1 elective subject amount to** | | **4** | | **4** |

| | Elective subjects 2<br>Wahlpflichtkatalog 2 | | SS | Ex | CP |
|---|---|---|---|---|---|
| AA2404 | Astronomy and Astrophysics | | 4 | P | 4 |
| OO2404 | Astrophysics of Variable Objects | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

| | Elective subjects 3<br>Wahlpflichtkatalog 3 | | SS | Ex | CP |
|---|---|---|---|---|---|
| VT2404 | Vector and Tensor Analysis | | 4 | P | 4 |
| ZF2404 | Modern Fortran | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

| | Elective subjects 4<br>Wahlpflichtkatalog 4 | | SS | Ex | CP |
|---|---|---|---|---|---|
| FE2404 | Physical Electronics | | 4 | P | 4 |
| EA2404 | Physical Foundations of Emission and Absorption Processes | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

| | Elective subjects 5<br>Wahlpflichtkatalog 5 | | SWS | Ex | CP |
|---|---|---|---|---|---|
| YF2504 | Fundamentals of Semiconductor Physics | | 4 | P | 4 |
| YA2504 | Physics of Semiconductor Devices | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

| | Elective subjects 6<br>Wahlpflichtkatalog 6 | | SWS | Ex | CP |
|---|---|---|---|---|---|
| IN2604 | Interaction of Ionizing Radiation with Matter | | 4 | P | 4 |
| KE2604 | Medical Physics | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

| | Elective subjects 7<br>Wahlpflichtkatalog 7 | | SWS | Ex | CP |
|---|---|---|---|---|---|
| LF2604 | Laser Physics | | 4 | P | 4 |
| AO2604 | Applied Optics | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

| | Elective subjects 8<br>Wahlpflichtkatalog 8 | | SWS | Ex | CP |
|---|---|---|---|---|---|
| PF2704 | Fundamentals of Polymer Physics | | 4 | P | 4 |
| PK2704 | Fundamentals of Polymer Physics and Chemistry | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

| | Elective subjects 9<br>Wahlpflichtkatalog 9 | | SWS | Ex | CP |
|---|---|---|---|---|---|
| QJ2704 | Solid State Physics | | 4 | P | 4 |
| QK2704 | Kinetic Phenomena in Solids | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

| | Elective subjects 10<br>Wahlpflichtkatalog 10 | | SWS | Ex | CP |
|---|---|---|---|---|---|
| NA2704 | Fundamentals of Nanophysics | | 4 | P | 4 |
| NF2704 | Physics of Nanomaterials | | 4 | P | 4 |
| | **2 elective subjects amount to** | | **4** | | **4** |

The faculty reserves the right to determine a minimum number of participants for offering an elective subject. Admission to mandatory modules is subject to available capacities. The possibility to obtain the required number of credit points remains unaffected. / Die Fakultät behält sich das Recht vor, eine Mindestteilnehmerzahl für das Zustandekommen eines Wahlpflichtkurses festzulegen. Die Zulassung zu Pflichtmodulen erfolgt vorbehaltlich freier Kapazitäten. Die Möglichkeit des Erreichens der vorgeschriebenen

In case of new developments in the different fields of Sustainable Agriculture the faculty reserves the right to expand the range of elective modules by further study courses over the time. / Die Fakultät behält sich vor, das Wahlpflichtangebot im Laufe der Zeit bei neuen Entwicklungen in verschiedenen Feldern der nachhaltigen Landwirtschaft durch weitere Fächer zu erweitern.

*** The actual selection from any study programme of the Rhine-Waal University has to be approved by the Examination Committee of the Faculty of Life Sciences. / Die konkrete Auswahl aus dem Studienangebot bedarf der Zustimmung des Prüfungsausschussvorsitzenden. /

Abbreviations: // Abkürzungen
CH = credit hours per week // SWS = Semesterwochenstunden
WS = winter term // Wintersemester
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Ex/Prü = type of examination // Prüfungsart
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LC/Pr = lab course // Praktikum
Pro = project // Projekt
T = certificate // Testat (unbenotet)
P = examination (graded) // benotete Prüfung

| | total | 1.Sem | 2.Sem | 3.Sem | 4.Sem | 5.Sem | 6.Sem | 7.Sem | 8. Sem |
|---|---|---|---|---|---|---|---|---|---|
| CH | 36 | 0 | 0 | 0 | 6 | 10 | 10 | 10 | 0 |
| CP | 40 | 0 | 0 | 0 | 6 | 12 | 10 | 12 | 0 |

*ECTS will only be credited after completing all parts of the module.
ECTS 7arden erst nach vollständigem Ableisten aller Modulteile gutgeschrieben.
** In addition to the General Examination Regulations for Bachelor 's Degree Programmes regarding the admission to the internship or study abroad the student has to show the successful completion of all modules/module examinations of the first study year of the study programme.
Ergänzend zu den Voraussetzungen der Rahmenprüfungsordnung zur Zulassung zum Praxis- oder Auslandsstudiensemester hat der/die Studierende das erfolgreiche Ableisten sämtlicher Module/Modulprüfungen des 1. Studienjahres des Studiengangs nachzuweisen.

The elective subjects hold true as in the fulltime version.

| UYTB104 | Modern History of Uzbekistan | | |
|---|---|---|---|
| | | | |
| Academic semester | 1 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 30 h |
| Seminars | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Khomitov Ravshan; Prof., Dr. Ermetov Avaz; Prof., Dr. Soipova Kamola;
Senior Lecturer Olimjonov Khabibjon

**Course content**

Introduction. Subject, goals, and objectives of the academic course “Contemporary History of Uzbekistan,” its theoretical and methodological foundations. Stages of formation and development of Uzbek statehood. Socio-political processes in Uzbekistan on the eve of gaining independence. The historical significance of the establishment of the independent Republic of Uzbekistan. Uzbekistan’s unique path to sovereignty and development. Formation of the foundations of a democratic, civil society in Uzbekistan and the political reforms carried out. Socio-economic changes in Uzbekistan during the years of independence. Spiritual and cultural development of Uzbekistan in the years of independence. The Republic of Karakalpakstan during the years of independence. Uzbekistan and the world community. Reforms carried out in the New Uzbekistan.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- possess knowledge of the contemporary history of Uzbekistan; the processes of Uzbekistan’s integration into the world community under modern conditions; issues of ensuring security, interethnic harmony, and religious tolerance; understand the role of historical science in the development of society and human worldview; and have the skills to recognize the connection between contemporary events and significant historical facts[1]
- apply the idea of national independence when studying issues of contemporary history of Uzbekistan and in shaping a worldview; understand the significance of the growth of the Republic of Uzbekistan’s international ranking and prestige from a historical and objective perspective[2]
- scientifically substantiate and express their views on spiritual, national, and universal issues; possess the competencies of an active life stance based on the ideas of national independence[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work;

**Admission requirements**

Mandatory Mandatory: No
Recommended: History of Uzbekistan, World History

**Bibliography**


1. Mustaqil O‘zbekiston tarixi. Mas’ul muharrir A.Sabirov. – Toshkent: Akademiya, 2013.
2. Новейшая история Узбекистана. Руководитель проекта и редактор. М.А.Рахимов. – Тошкент: Адабиёт учкунлари, 2018.
3. Rasulova N. O‘zbekistonning eng yangi tarixi. 1-qism. – Toshkent, 2021. – 186 bet.
4. O‘zbekistonning eng yangi tarixi. R.H.Murtazayeva, A.A.Ermetov, A.A.Odilov. – Toshkent, 2023.

Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| Type of Assessment | CA | FA |
|---|---|---|
| Timing | 8 th week | 16-17 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completing sections related to lectures and seminar sessions, covering half of the total course content. The studied material will be divided into variants, each containing 1 complex question and 2 simple questions. Answers will be accepted in both written and oral form. The student submits a written answer and then responds orally to the questions posed, with the opportunity to earn up to 5 points for each answer. The student can receive a maximum of 5 points for each correct answer.

**Final Assessment:** conducted based on prepared variants covering all topics studied during the course. The material will be divided into variants, each containing 1 complex question and 2 simple questions. Answers are accepted in written form. The final grade is calculated based on the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials.

| FALB104 | Philosophy | | |
|---|---|---|---|
| | | | |
| Academic semester | 2 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 30 h |
| Seminars | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof. Dr. Tulyayev Avaz; Associate Prof. Dr. Shodimetova Gulchekhra; Prof., Dr. Mukhamadiyeva Oynisa; Prof., Dr. Agzamova Nilyufar

**Course content**

Philosophy and its role in the life of society. Stages of development of philosophical thought: Eastern philosophy. Stages of development of philosophical thought: Western philosophy. Philosophy of being (ontology) and philosophy of development. Philosophy of knowledge (epistemology). Logic. Forms of thinking: concept, judgment, and inference. Philosophy of society. Philosophy of the human being (philosophical anthropology). Philosophy of values (axiology). Philosophy of morality (ethics). Philosophy of the beautiful (aesthetics). Philosophy of globalization and sustainable development. World experience in combating corruption. Uzbekistan's policy in combating corruption.

**Learning objectives**

Upon successful completion of this course, students should:

- know the key stages in the development of philosophical thought: Ancient Eastern, Ancient, Medieval, Modern, and Contemporary philosophy; the main categories and concepts of philosophy: being, matter, consciousness, cognition, truth, values, personality, society; understand the role of philosophy in shaping the scientific worldview and the methodology of physics; be familiar with modern philosophical concepts related to ontology, epistemology, and axiology; understand the interconnection between philosophy and physics, especially in terms of the scientific method, the limits of knowledge, and the ethics of scientific research; understand the significance of philosophy in the context of globalization, digitalization, and the environmental and technological challenges of the modern era[1]
- be able to use philosophical categories and methods to analyze problems in physics and scientific knowledge; apply the principles of logic and critical thinking in argumentation, constructing proofs, and scientific reasoning; use philosophical ideas when discussing the scientific, ethical, and social aspects of a physicist's professional activity; analyze philosophical texts and extract their main arguments, positions, and worldview foundations[2]
- be capable of forming one's own position on fundamental questions of being, knowledge, science, and ethics; critically evaluate social and cultural phenomena from the perspective of philosophy and science; synthesize philosophical and scientific knowledge to develop a responsible attitude toward scientific issues; engage in dialogue about the philosophical foundations of science, free will, the responsibility of the scientist, and the values and goals of scientific progress[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work;

| Admission requirements |
|---|
| Mandatory: No<br>Recommended: History of Uzbekistan, World History |
| Bibliography |
| 1. Davronov Z., Shermuhamedova N, Qahharova M, Nurmatova M, Husanov B, Sultonova A. Falsafa. – Toshkent: TMU, 2019<br>2. Madaeva Sh. Shermuhamedova N. Va boshqalar. Falsafa – o‘quv qo‘llanmasi. – Toshkent: 2019<br>3. Muhammadjonova L.A. L.A. Abdulla Sher, Shodimetova G. Axloq falsafasi. – Toshkent: Vneshinvestprom, 2023<br>4. Saifnazarov I. Muxtorov A., Sultanov T., Usmonov F. Falsafa. Darslik. –T.: Innovatsion rivojlanish nashriyot – matbaa uyi, 2021.-424 b.<br>5. Саифназаров И.С., Абдуллаханова Г.С., Эрназаров Д.З. Философия (Логика, Этика, Эстетика). Учебное пособие для высших учебных заведений.LAMBERT Academik Publishing RU. 2019. -134 стр.<br>6. Shermuhamedova N. Falsafa. – Toshkent: Idris Abdurauf Nashr, 2021. 667-b |
| Assessments |
| Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system. |

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 29-30 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completing sections related to lectures and seminar sessions, covering approximately half of the total course content. The studied material will be divided into sets, each containing 1 complex question and 2 simple questions. Answers will be accepted in both written and oral form. The student submits a written answer and then responds orally to the questions posed, with the possibility of earning up to 5 points for each answer. A maximum of 5 points is awarded for each correct answer.

**Final Assessment:** conducted based on prepared sets covering all topics studied during the course. The material will be divided into sets, each containing 1 complex question and 2 simple questions. Answers are accepted in written form. The final grade is calculated as the arithmetic mean.

| Educational Materials and Media Tools |
|---|
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| URTB104 | Uzbek (Russian) Language | | |
|---|---|---|---|
| | | | |
| Academic semester | 1 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Practical classes | 60 h | Preparation for classes | 30 h |
| | | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

Lecturers

Senior Lecturer Aliyev Farkhodbek; Senior Lecturer Otajonova Feruza; Senior Lecturer Khasanova Parizod

Course content

**Uzbek language:** Uzbekistan – the only Homeland. Orthoepic rules; the Uzbek language as the state language. Orthographic rules of the Uzbek language. National values – pride of the nation. Word formation in the Uzbek language. History and the present. Lexical layers of the language. Education in the modern world. Language and terminology. Museums – a bridge between the past and the future. Sector-specific terms and their application. Reading books. Free and fixed word combinations. Types of phraseological units. Literature – a source of spiritual elevation. Speech styles. Literary style. Mass media. Internet culture. Publicistic style and its features. Innovations in the 21$^{st}$ century. Scientific style and its methodological features. Global issues of modern times. Articles and their types. Nature and humans. Rules for conducting interviews. Procedure for preparing reports. Legal culture. Formal–official style and its features. From the life of our scientific community. Conversational style and its features. Dialect-specific words. Life in my imagination. Text and its manifestations. Types of dialogic texts according to semantic relations. Mentor's school. Monologic text. Sequence of content and tone in monologic text. The history of my profession. Sectoral dictionaries – issuing terms and combinations. A mature specialist. Text analysis and editing. The path to science. Annotative and review texts, features of material expression in them. Professional ethics. Speech etiquette. The concept of the norm. Art and spirituality. Artistic terms that have entered the common vocabulary. The work I love. Tools of artistic representation. Economy and life. Economic terms that have entered the common vocabulary. Language and meeting management style.

**Russian language:** Acquaintance. Phonetic and orthoepic norms of the Russian language. Parts of speech (noun, adjective, numeral, pronoun, verb). Prepositional-case system: nominative case, prepositional case, accusative case, genitive case, dative case, instrumental case. Verbs, their forms and usage (past, present, future tense). Verbs of motion; aspect (perfective, imperfective). Common vocabulary. Expression of object–explanatory relations in simple and complex sentences. Expression of temporal relations in simple and complex sentences. Expression of connection (addition), comparison, juxtaposition, opposition. Expression of attributive relations in simple and complex sentences. Expression of spatial relations in simple and complex sentences. Expression of cause-and-effect relations in simple and complex sentences. Expression of conditional and concessive relations in simple and complex sentences. Expression of purpose relations in simple and complex sentences. Speech styles: functional speech styles. Scientific style of speech and its features. Abstract. Structure of an abstract. Annotation. Linguistic and syntactic means of scientific speech. Expression of subject–predicate relations. Expression of object relations in sentences. Expression of object–explanatory relations. Expression of attributive relations in sentences. Expression of connection (addition), comparison, juxtaposition, opposition. Expression of spatial relations in sentences. Review. Structure of a review.

Learning objectives

Upon successful completion of this course, students should be able to:

- possess linguistic and speech norms of modern Uzbek (Russian) in the professional field of the chosen specialty; be able to construct monologic statements in Russian on professional topics[1]
- independently search for scientific information as the basis for professional activity; clearly express one's thoughts orally and in writing on professionally significant topics; work independently when preparing presentations, reports, and abstracts on professional topics; be able to conduct a dialogue, participate in a polylogue on a given topic, as well as produce secondary scientific texts (annotation, abstract, summary); be able to summarize and interpret scientific information, use the main techniques for processing oral and written texts, applying scientific vocabulary and constructions of scientific speech[2]
- possess the skills of preparing annotations and abstracts, selecting linguistic means in accordance with the communicative intent and the communication situation; be able to use etiquette forms of scientific and professional communication; be able to clearly state one's point of view on a scientific problem in Uzbek (Russian); translate informational messages (without a dictionary) and texts in the specialty (with a dictionary) from Uzbek (Russian) into one's native language[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Practical classes; Self-study; Group work;

Admission requirements

Mandatory: No

Recommended: Be able to express and understand one's opinion on everyday life topics

Bibliography


1. AbdurahmonovaM., Fattaxova D., Xalmuxamedova U., Inogamova N., Egamberdiyeva N. O'zbek tili (o'quv qo'llanma) – Toshkent: Mumtoz so'z, 2018. – 276 b.
2. Iskandarova O.R. O'zbek tili. (O'quv qo'llanma) – Toshkent: Firdavs-Shoh nashriyoti, 2023, – 174 b.
3. Husanov N., Xo'jaqulova R., Dilmurodova N. O'zbek tili (darslik). – Toshkent: TMI, 2020, – 515 b.
4. Исакова Р.К., Бегматова Н.А.,Турсунова И.М., Хаитбаева Н.Х. Вводно-корректировочный курс русского языка. Т.: НУУз., 2019
5. Исакова Р.К., Калинина О.Н., Турсунова И.М. и Dr. Пособие по русскому языку (часть-1) – Т.:Fan va texnologiya, 2019
6. Исакова Р.К. Русский язык. Профессиональная речь. Сурхандарья: Fidokor Yosh Avlod, 2023
7. Учебные и методические пособия по языку специальности-Т.: Университет, 2019, 2020,2021, 2022


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| Type of Assessment | CA | FA |
|---|---|---|
| Timing | 29 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completing sections related to lectures and seminar sessions, covering approximately half of the total course content. Answers will be accepted in both written and oral form. The student submits a written answer and then responds orally to

| |
|---|
| the given questions.<br>**Final Assessment:** conducted based on prepared sets covering all topics studied during the course. Answers will be accepted in both written and oral form. The student submits a written answer and then responds orally to the given questions. |
| Educational Materials and Media Tools |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| XJTB104 | Foreign Language | | |
|---|---|---|---|
| | | | |
| Academic semester | 1 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Practical classes | 60 h | Preparation for classes | 30 h |
| | | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Senior Lecturer Agzamova Zamira (eng); Senior Lecturer Urmonova Nigorakhon (fr); Senior Lecturer Amirova Akida (germ);

**Course content**

General topics – about oneself, family, daily routine, favorite activities, leisure time, everyday life, etc.;
Social topics – everyday issues, personality and professional psychology, ethics, environmental protection, global problems;
Socio-cultural topics — situations related to science and the professional sphere, cultural differences, countries of the studied language, their culture, social characteristics, and the importance of a foreign language;
Educational topics – the education system, lifelong learning, leading universities of the world, lectures, scientific articles, thesis writing, reading, learning, and presentation strategies;
Topics related to the Internet and information technologies — news of science and technology in the world and in our country, achievements, inventions, use of Internet networks, the latest technologies;
Topics related to the professional sphere — fields of professions, current topics, document preparation, professional ethics, conducting negotiations, scientific and applied ideas in the professional field, innovative ideas and innovations, leading scientists in the industry and their contribution to science.
In practical classes, speech competence is developed through the integration of reading, writing, listening, and speaking skills. The topics are determined based on the specifics of the subject and professional orientation and serve as a basis for developing language skills. In this process, it is recommended to effectively use various teaching methods and technologies. For example:
Dialogue — conversations on social topics and informal dialogues; formal and informal discussions on professional or other topics; conducting interviews, telephone negotiations, etc.
Monologue — preparation and delivery of lectures on professional topics, discussions, presenting arguments and evidence, expressing one’s opinion; preparation and delivery of presentations, writing and analyzing articles.
Reading — skimming, scanning, and intensive reading for skill development; reading letters, messages, and emails; reading specialized texts containing authentic materials; reading texts with professional and scientific terminology, literature in the specialty, electronic sources, and press.
Writing — writing various texts, letters, and messages, special documents (e.g., CVs, etc.); writing essays, summaries, reports, scientific and graduation qualification papers.
Listening — listening to authentic materials twice to understand the main content, obtain necessary information, and reproduce it; understanding daily news, reports, and speech in films, etc.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- develop the lexical and grammatical foundation necessary for communication on everyday, academic, and professional topics; understand the content of written and oral texts related to professional and scientific activities[1]
- apply foreign language abilities in oral and written form to solve communicative tasks in academic, professional, and everyday contexts; participate in discussions, interviews, business negotiations, and presentations, taking into account speech norms and cultural differences; analyze the structure and content of scientific and professional texts; interpret main ideas and arguments[2]
- conduct comparative analysis of authentic sources of information (scientific articles, reports, interviews, professional dialogues); formulate and express personal opinions on professional and scientific topics in oral and written form using appropriate terminology; create written texts (essays, reports, CVs, abstracts, scientific articles) on topics related to the future profession; develop strategies for independent foreign language learning, including searching for, selecting, and using authentic materials; demonstrate the ability to critically evaluate information obtained in a foreign language and apply it in professional activities[3]

[1] knowledge; [2] skills; [3] abilities;

## Teaching and learning methods

Practical classes; Self-study; Group work;

## Admission requirements

Mandatory: No
Recommended: Be able to express and understand one's opinion on everyday life topics

## Bibliography


1. Tim Falla, Paul A. Davis, Solutions Elementary. Student's Book, 3-rd edition. Oxford University press, 2017
2. Tim Falla, Paul A. Davis, Solutions Pre-Intermediate. Student's Book, 3-rd edition. Oxford University press, 2017
3. Tim Falla, Paul A. Davis, Solutions Intermediate Elementary. Student's Book, 3-rd edition. Oxford University press, 2017
4. Shirinova R.X. Fransuz tili // Darslik. – T.: Sano standart, 2015 (ikkinchi nashr, 2017).
5. O'rmonova N.M., Raximova M.A. Le français niveau B1. Toshkent. Yosh avlod matbaa. 2021.
6. Girardet J., Pecheur J. Et d'autres. Tendances. Methode de français. CLE International, 2016. P.161.
7. Alikulova D.A., Jo'raboeva D.A. Fransuz tili darsligi. –T.: O'zbekistan. 1999, 2003 yil nashrlari.


## Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| Type of Assessment | CA | FA |
|---|---|---|
| Timing | 9 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completing sections related to lectures and seminar sessions, covering approximately half of the total material. Answers are accepted in both written and oral form. The student submits a written answer and then responds orally to the given questions.

**Final Assessment:** conducted based on prepared sets covering all topics studied. Answers are accepted in both written and oral form. The student submits a written answer and then responds orally to the given questions.

## Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| DINB204 | Religious Studies | | |
|---|---|---|---|
| | | | |
| Academic semester | 3 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 30 h |
| Seminars | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

Lecturers

Associate Prof. Dr. Tangirov Nizom; Associate Prof. Dr. Tulyayev Avaz

Course content

The significance of religion as a phenomenon of social culture. National religions. The religion of Zoroastrianism. The Buddhist religion. The Christian religion. The religion of Islam. Dogmatic branches and schools of Islam. The role of the Hanafi madhhab in the history of Central Asia. Religious organizations operating in Uzbekistan. Modern religious movements and sects. The social danger of promoting religious beliefs in cyberspace. The political and social dangers of missionary activity and proselytism. The history and trends of religious fundamentalism, radicalism, and terrorism. The world community's experience in combating extremism and terrorism. The importance of achieving unity between sensory knowledge and religious beliefs.

Learning objectives

Upon successful completion of this course, students should:

- to know the basic concepts and terms of religious studies — religion, faith, cult, sect, fanaticism, extremism, tolerance, secularism; the historical stages of the development of religious teachings and their main characteristics; the core tenets of the world religions – Buddhism, Christianity, Islam, and their branches; the specific features of the interconnection between religion, science, and philosophy in the history of culture; to understand the causes of the emergence of religious fundamentalism, fanaticism, extremism, the essence of religious faith, customs, traditions, and their significance for the individual and society; to understand the difference between secular and religious knowledge, as well as between authentic religious teachings and their distorted interpretations; to understand the influence of religion on worldview, social relations, and intercultural interactions[1]
- to be able to apply religious studies knowledge to analyze religious phenomena in modern society; to use religious and philosophical arguments in discussions on the role of religion, morality, and spiritual values; to apply acquired knowledge in the prevention of extremism and religious intolerance in everyday and professional activities; to analyze differences and similarities in the beliefs, rituals, and social functions of world religions; to analyze the texts and ideas of religious teachings, identifying their key points and arguments[2]
- to identify the relationship between religious views and social, political, and cultural processes; to develop one's own critical attitude toward issues of religious faith, secularism, and interreligious dialogue; to assess religious, cultural, and political phenomena from the perspective of the values of tolerance, peace, and humanism; to synthesize knowledge of religion, philosophy, and society to develop a responsible attitude toward religious culture and spiritual security; to engage in dialogue with representatives of different worldviews, respecting religious diversity and recognizing the

importance of interfaith interaction[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Lectures; Seminars; Self-study; Group work;

Admission requirements

Mandatory: No
Recommended: History of Uzbekistan, World History

Bibliography

1. Muratov D., Alimova M., Karimov J. Dinshunoslik, darslik.– Toshkent, «Navro‘z» nashriyoti, 2019. – 264 b.
2. Raximdjanov D., Ernazarov O. Dinshunoslikka kirish. O’quv qo’llanma. – T.: «O’zbekiston faylasuflari milliy jamiyati» nashriyoti, 2018. – 304 b.
3. Isoqjonov R. Qiyosiy dinshunoslik. O‘quv qo‘llanma. – T.: OOO «Complex print», 2020. – 198 b.
4. Kamilov D. Dinshunoslik. O’quv qo’llanma. – T.: Lesson Press, 2021. – 128 b.
5. Shermuxamedova N.A.Diniy fanatizm fenomeni//Inson falsafasi.
– T.: Noshir, 2016. B.314-499.

Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| Type of Assessment | CA | FA |
|---|---|---|
| Timing | 8 th week | 16-17 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment**: conducted after completing sections related to lectures and seminar classes in the amount equal to half of the total course content. The studied material is distributed into versions, each containing 1 complex and 2 simple questions. Answers are accepted in written and oral form. The student submits the written answer, then responds orally to the given questions, and can earn up to 5 points for each correct answer.

**Final Assessment**: conducted based on compiled versions covering all completed topics. The studied material is distributed into versions, each containing 1 complex and 2 simple questions. Answers are accepted in written form. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| UPPB308.1 | General Pedagogy. Psychology 1 (General Pedagogy) | | |
|---|---|---|---|
| | | | |
| Academic semester | 5 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 30 h |
| Seminars | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Sodikov Ulugbek; Associate Prof. Dr. Babashev Farkhad

**Course content**

Methodological foundations of pedagogy. The subject of pedagogical science and research methods. Modernization processes in the education system of the Republic of Uzbekistan. Theory of education. The essence of the educational process. Organizational forms and teaching methods. Innovative methods in education. Theory of education. Education in the pedagogical process. Methods and forms of the educational process. Fundamentals of social pedagogy. Fundamentals of pedagogical activity. The content of the pedagogical profession and activity. Pedagogical competence and creativity. Management of the education system. Education management. The school as an object of management. Modern trends in pedagogy. Pedagogical diagnostics. Fundamentals of media education. Fundamentals of inclusive education.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the essence and structure of the pedagogical process, the goals and objectives of education, the main methods of teaching and upbringing, and the forms of pedagogical activity; the fundamentals of pedagogical diagnostics, the principles of building an education system, the features of inclusive and innovative education; understand the integrity of the pedagogical process, the interconnection of the components of teaching and upbringing, the importance of pedagogical technologies and resources; understand the principles of designing curricula and programs, methodological guides, and documentation in educational institutions[1]
- be able to apply teaching and upbringing methods in educational practice, manage the educational process using pedagogical and information technologies; organize educational activities taking into account the age and individual characteristics of students, as well as the goals and objectives of personality development; develop and use pedagogical resources, maintain educational and methodological documentation, and adapt the content and forms of teaching to an inclusive environment[2]
- be capable of conducting pedagogical diagnostics, interpreting the results, and making managerial decisions based on them; independently developing, analyzing, and implementing innovative methods and forms of teaching in the educational process; carrying out pedagogical research, summarizing and disseminating advanced pedagogical experience, and forming one's own pedagogical strategy; integrating the results of theoretical and practical pedagogical developments into the system of professional education[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: No

Bibliography


1. Axrarova Z., Sodikov U., Allayarova S., Sadikova Sh., Shodmonov Sh. –Umumiy pedagogika. O‘quv qo‘llanma. -T: “Mumtoz so‘z”, 2021. 331 b.
2. Модиков У., Тахирова М. Общая педагогика. Учебное пособие. - Т.: “Mumtoz so‘z”, 2021. - 312 с.
3. Худайкулов Х. Основы педагогического мастерства. Учебное пособие. –Т.: “Innovatsiya-Ziyo”, 2021. - 208 с.
4. Голованова Н., Педагогика: учебник и практикум для вузов - 2-е изд., перераб. и доп. - М: Издательство Юрайт, 2023. - 372 с.
5. Коджаспирова Г. М., Педагогика: учебник для вузов. - 4-е изд., перераб. и доп. — М.: - М: Издательство Юрайт, 2023. - 711 с.


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 8-9 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completing the sections related to lectures and problem-solving, covering half of the total course content. The studied material will be divided into sets, each containing 3 questions. Answers will be submitted in written form. The student can receive a maximum of 5 points for each correct answer.

**Final Assessment:** conducted based on prepared sets covering all topics studied during the semester. Each student will be given a set containing 3 questions on the topics covered throughout the semester. Answers will be submitted in written form. After submitting the written answer, the student will then respond to the given questions orally and can receive a maximum of 5 points for each answer. The final grade will be calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| UPPB308.2 | General Pedagogy. Psychology 2 (Psychology) | | |
|---|---|---|---|
| | | | |
| Academic semester | 6 | ECTS | 8 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 30 h |
| Seminars | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Khudoynazarov Tursunali; Associate Prof., Dr. Usmanov Murodbek

**Course content**

History, subject, and functions of psychology. Scientific research methods in psychology. Development of the psyche and mind. Structure of activity. Personality psychology. Attention and its psychological characteristics. Cognitive processes as the basis of the psyche. Understanding intuition. Cognition and knowledge acquisition. Memory as a psychological concept. Imagination and fantasy. Concept of thinking. Psychological characteristics of speech. Psychology of communication. Emotions and emotional expressions. Will and volitional actions. Temperament and its types. The concept of character and its manifestation in life. Abilities and talents.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the subject, objectives, and methods of psychological science; the main concepts and categories of general psychology; stages of development and formation of the psyche; patterns of mental processes such as perception, thinking, memory, emotions, and will; individual psychological characteristics of personality, as well as traits of temperament, character, and motivation; understand the structure and dynamics of mental processes, personal characteristics and their influence on behavior and activity; understand the relationship between physiological characteristics and psychological manifestations[1]
- be able to analyze a person's emotional and volitional states, features of motivation and behavior in different life situations; take into account individual and age-related characteristics in pedagogical and educational processes; select psychophysiological workloads depending on the type of nervous system and adapt approaches to individuals based on their personality[2]
- be capable of applying general psychological knowledge in everyday and professional activities (in pedagogy, social work, management); performing psychological self-analysis, evaluating one's own mental states and capabilities, and adjusting them under various working conditions; summarizing modern psychological knowledge, critically assessing different theories and approaches, and using them in independent projects and research[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: No

**Bibliography**

1. G‘oziyev E.G. Umumiy psixologiya. Toshkent. 2010.
2. Ivanov P.I., Zufarova M. Umumiy psixologiya T.: O‘zbekiston faylasuflar milliy jamiyati, 2008.
3. A.Shamshetova, R.N.Melibaeva, X.Usmanova, I.Haydarov. Umumiy psixologiya. T. 2018.
4. David G. Mayers Psychology, USA , 2010.

## Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 28-29 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completing sections related to lectures and problem-solving, covering half of the total course content. The studied material will be divided into sets, each containing 3 questions. Answers will be submitted in written form. The student can receive a maximum of 5 points for each correct answer.

**Final Assessment:** conducted based on prepared sets covering all topics studied during the semester. Each student will be given a set containing 3 questions on the topics covered throughout the semester. Answers will be submitted in written form. After submitting the written answer, the student will then respond to the given questions orally and can receive a maximum of 5 points for each answer. The final grade will be calculated as the arithmetic mean.

## Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| MEXB1061 | Mechanics | | |
|---|---|---|---|
| | | | |
| Academic semester | 1 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 60 h | Preparation for classes (review of lecture material, Problem solving) | 30 h |
| Problem solving | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 60 h |
| Total | 90 h | Total | 90 h |
| Total work-load | 180 h | | |

**Lecturers**

Prof., Dr. Tursunmetov Komil; Associate Prof., Dr. Abdullayev Rakhmatullo; Prof., Dr. Rakhmonov Ganiboy

**Course content**

Fundamentals of kinematics. Curvilinear motion. Motion of a body thrown horizontally and at an angle to the horizon, and their equations of motion. Newton's third law and its applications. Constrained motion of a body. Motion of a body with variable mass. Deformation and its types. Motion of a body in a non-inertial reference frame. Types of friction and frictional forces. Translational and rotational motion of a rigid body. Angular momentum. Law of change of angular momentum. Steiner's theorem and its applications. Basic laws of dynamics for rigid body motion. Free axes of rotation. Law of universal gravitation. Motion of Earth's satellites and spacecraft. States of matter. Law of conservation of energy in fluid flow. Torricelli's formula. Periodic processes. Physical pendulums, their types and equations of motion. Energy changes in free oscillations and their graphs. Forced oscillations. Superposition of oscillations. Concept of a wave. Plane sinusoidal wave. Wave interference. Doppler effect.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the fundamental laws and principles of classical mechanics: Newton's laws, the law of universal gravitation, conservation laws of momentum, angular momentum, and energy; the physical basis of mechanical motion: kinematics, dynamics, statics, motion with and without acceleration, motion in non-inertial reference frames; main types of mechanical interactions and processes: deformations, friction, oscillations, waves, states of matter; understand the meaning and applicability of fundamental laws of mechanics, including the influence of external forces, resistance, and variable mass[1]
- be able to apply the laws of mechanics to solve problems of varying complexity, including practical problems from engineering, technology, and daily life; analyze mechanical systems: translational and rotational motion, pendulums, satellites, collisions, and stability of bodies; plan and conduct laboratory experiments in mechanics, use measuring instruments, and analyze experimental data; possess skills in measuring mechanical quantities and converting units in different systems (SI, CGS, etc.)[2]
- possess skills to interpret and explain mechanical phenomena based on physical laws and models; be able to formulate physical hypotheses and test them using observations and calculations; demonstrate the ability to generalize and transfer knowledge to interdisciplinary and practical contexts (e.g., in engineering and natural sciences); possess skills to set up and perform physical experiments — from defining the goal to processing results and drawing conclusions[3]

[1] knowledge; [2] skills; [3] abilities;

| Teaching and learning methods |
|---|
| Lectures; Problem solving; Self-study; Group work |
| **Admission requirements** |
| Mandatory: No<br>Recommended: Knowledge of high school physics, mathematical analysis, and geometry. |
| **Bibliography** |
| 1. Strelkov S.P. Mexanika-Toshkent, «Universitet,» 2022.<br>2. Алешкевич В. А., Деденко Л. Г., Караваев В. А.. Механика. – М.: Изд. Центр«Академия», 2004. −480 с.<br>3. Jearl Walker, David Hallidey., R.Resnick. Fundamentals of physics. ISBN 978-8808-08797-3. 2014.<br>4. Tursunmetov K.A. Umumiy fizika. Mexanikadan laboratoriya ishlari. O‘zMU, 2021y.<br>5. Douglas C. Giancoli. Physic sprinciples withapplications. 2014<br>6. Chertov A.G., Vorobyev A.A. Fizikadan masalalar to‘plami. O‘quv qo‘llanma. –T.: “Ma’rifat”, 2024. 612 bet.<br>7. Abdumalikov A.A., Sattorov X.M. Mexanika. – T. Donishmand ziyosi, 2020. −280 bet |
| **Assessments** |
| Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.<br><br>**Type of Assessment** — **CA** — **FA**<br>Timing — 8-9 th week — 19-20 th week<br>Form of Assessment — written exam — written and oral exam<br><br>**Continuous Assessment:** Conducted after completing sections related to lectures and problem-solving, covering half of the total course material. The material will be divided into variants, each containing 3 theoretical questions and 1 problem. Answers will be accepted in written form. A student can receive up to 5 points for each correct answer.<br>**Final Assessment:** Conducted based on variants covering all topics studied during the semester. Each student will receive a variant containing 3 theoretical questions and 1 problem on the studied topics. Answers will be accepted in written form. After submitting the written answers, the student will answer the given questions orally and can receive up to 5 points for each answer. The final grade is calculated as the arithmetic mean. |
| **Educational Materials and Media Tools** |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| MANB112.1 | Mathematical Analysis 1 | | |
|---|---|---|---|
| | | | |
| Academic semester | 1 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Prof., Dr. Tishabayev Djurabay; Prof., Dr. Imamkulov Sevdiyor; Prof., Dr. Sobirov Zarif; Associate Prof., Dr. Rakhimov Kamoliddin

**Course content**

The set of real numbers and its properties. Operations on real numbers. The concept of a function. Boundedness of a function, its monotonicity, parity and oddness, periodicity. Inverse function. Composite function. Elementary functions and their properties. Limit of a numerical sequence. Properties of convergent sequences. Limit of monotonic sequences. The nested intervals principle. Subsequences. Bolzano–Weierstrass lemma. Fundamental sequences. Cauchy theorem. Limit of a function and properties of functions having a limit. Theorems on the existence of a limit of a function. Important limits. Infinitesimal and infinite functions. Comparison of functions. Continuity of a function, local and global properties of continuous functions. Existence and continuity of an inverse function. Uniform continuity. Cantor's theorem. Derivative of a function. Geometric and mechanical meaning of the derivative. Rules and formulas of differentiation. Differentiability of a function. Differential of a function. Approximate computation formula. Higher-order derivatives and differentials. Fundamental theorems of differential calculus. L'Hôpital's rules. Taylor's formula. Maclaurin formulas for certain elementary functions. Monotonicity of a function. Extrema of a function. Convexity, inflection points, asymptotes.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the properties of the set of real numbers, types of elementary functions and their behavior (boundedness, monotonicity, parity, periodicity), as well as the concepts of limit, continuity, and differentiability of functions and sequences; the main theorems of mathematical analysis: Bolzano–Weierstrass, Cauchy, Cantor, L'Hôpital's rules, Taylor's and Maclaurin's formulas; definitions and properties of infinitesimal and infinite functions, asymptotes, extrema, inflection points, and convexity of function graphs[1]
- be able to find limits of numerical sequences and functions, investigate functions for continuity, monotonicity, extrema, and convexity; apply differential calculus to analyze the behavior of functions, find derivatives and differentials of various orders; use the acquired knowledge to solve applied problems in physics and engineering (e.g., for approximate calculations, process analysis, and graph construction)[2]
- possess the skills to accurately compute limits, derivatives, and construct graphs of elementary functions considering their analytical properties; analyze and interpret calculation results, use methods of mathematical analysis to solve physical problems; logically and reasonably apply formulas and theorems of analysis in scientific research and engineering activities[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

| Admission requirements |
|---|
| Mandatory: No<br>Recommended: Knowledge of the high school course in mathematical analysis and geometry |
| **Bibliography** |
| 1. Tao T. Analysis 1, 2. Hindust n Book Ageocy, India, 2014.<br>2. Xudayberganov G., vorisov A. L, Mansuov x. T., Shoimqulov B. A. Matcmatik analizdan ma'ruzalar, I, II q. T. "Voris-nashriyot", 2010.<br>3. Shoimqulov B. A., Tuychiyev T. T., Djumaboyev D. X. Malemalik analizdan mustaqil ishlar. T. " O'zbekiston faylasuflari milliy jamiyati ", 2008.<br>4. Фихтенгольц Г.М. Курс дифференциального и интегрального исчисления, 1-3 тома, М. «Физматлит», 2007.<br>5. Alimov SH, O., Ashurov R.R. MatcrDatik analiz 1,2,3 q.T. "Mumtoz so l', 2018 |
| **Assessments** |
| Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.<br><br>**Type of Assessment** — **CA** — **FA**<br>Timing — 8-9 th week — 19-20 th week<br>Form of Assessment — written exam — written and oral exam<br><br>**Continuous Assessment:** conducted after mastering sections related to lectures and problem-solving in the amount equal to half of the total. The studied material will be divided into variants, each containing 3 theoretical questions and 1 problem. Answers will be accepted in written form. The student can receive a maximum of 5 points for each correct answer. **Final Assessment:** conducted based on prepared variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. The student submits a written answer, then answers the given questions orally and can score a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean. |
| **Educational Materials and Media Tools** |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| MANB112.2 | Mathematical Analysis 2 | | |
|---|---|---|---|
| | | | |
| Academic semester | 2 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Prof., Dr. Tishabayev Djurabay; Prof., Dr. Imamkulov Sevdiyor; Prof., Dr. Sobirov Zarif; Associate Prof., Dr. Rakhimov Kamoliddin

**Course content**

The concept of an antiderivative and the indefinite integral. Methods of integration. Integration of simple fractions. Integration of rational functions. Integration of certain irrational functions. Integration of trigonometric functions. The concept of the definite integral. Darboux sums. Properties of definite integrals. Mean value theorems. Applications of the definite integral: area of a plane figure, arc length and methods of its calculation. Applications of the definite integral in physics and mechanics. Improper integrals and their convergence. Improper integrals depending on a parameter. Euler integrals: beta and gamma functions. Space Rn. Function of several variables and its limit. Partial derivatives of a function of several variables. Differentiability of a function of several variables. Higher-order derivatives and differentials of a function of several variables. Extrema of such a function. Numerical series and properties of convergent series. Series with positive terms and convergence tests. Absolutely and conditionally convergent series: Abel's and Dirichlet's tests.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the concept of an antiderivative and the indefinite integral, methods of integrating rational, irrational, and trigonometric functions; definition of the definite integral, properties of the integral, Darboux sums, and mean value theorems; conditions for convergence of improper integrals, properties of Euler integrals (beta and gamma functions); the concept of a function of several variables, its limit, partial derivatives, and differentiability conditions; definitions and convergence criteria for numerical series, including Abel's and Dirichlet's tests[1]
- be able to perform integration of standard types of functions, apply the definite integral to calculate areas, arc lengths, and solve physical problems; find and analyze partial derivatives, differentials, and extrema of functions of several variables; investigate convergence of numerical series, use convergence tests in calculations; apply methods of multivariable analysis to applied problems in physics and engineering[2]
- possess the skills of integrating various classes of functions and practical application of the definite integral in physico-mechanical problems; analyzing functions of several variables: limits, partial derivatives, extrema; use series for approximate computations and convergence estimation in engineering calculations[1]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No

Recommended: Knowledge of the high school course in mathematical analysis and geometry

Bibliography


1. Tao T. Analysis 1, 2. Hindust n Book Ageocy, India, 2014.
2. Xudayberganov G., vorisov A. L, Mansuov x. T., Shoimqulov B. A. Matcmatik analizdan ma'ruzalar, I, II q. T. "Voris-nashriyot", 2010.
3. Shoimqulov B. A., Tuychiyev T. T., Djumaboyev D. X. Malemalik analizdan mustaqil ishlar. T. " O'zbekiston faylasuflari milliy jamiyati ", 2008.
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Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after mastering sections related to lectures and problem-solving in the amount equal to half of the total. The studied material will be divided into variants, each containing 3 theoretical questions and 1 problem. Answers will be accepted in written form. The student can receive a maximum of 5 points for each correct answer.

**Final Assessment:** conducted based on prepared variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. The student submits a written answer, then answers the given questions orally and can score a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| AAGB112.1 | Linear Algebra and Analytic Geometry 1 (Linear Algebra) | | |
|---|---|---|---|
| | | | |
| Academic semester | 1 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Prof., Dr. Makhammadiyev Farkhod; Associate Prof., Dr. Zoitov Azam; Dr. Mamadaliyev Nodirbek; Prof., Dr. Beshimov Ruzinazar

**Course content**

Vectors and linear operations on them. Projection of a vector onto an axis. Scalar product of vectors. Left- and right-handed coordinate systems. Vector and mixed products of vectors. Polar, cylindrical, and spherical coordinate systems. Equations of a straight line in a plane. Various equations of a plane in space. Relative positions of planes in space. Distance from a point to a plane. Equations of a straight line in space. Relative positions of lines in space. Relative positions of a plane and a line. Second-order curves in a plane. Ellipse and its canonical equation. Canonical equations of a hyperbola and a parabola. General equations of second-order curves. Center of a second-order curve. Central and non-central curves. Intersection of a second-order curve with a straight line. Transformation of the general equation of a second-order curve to canonical form. Theory of second-order surfaces. Second-order surfaces, their center, tangent and diametral planes. Equations of tangent planes to a sphere and an ellipsoid. General theory of curves and surfaces.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the basic concepts of analytic geometry and linear algebra: vectors and their operations (scalar, vector, and mixed products), coordinate systems (Cartesian, polar, cylindrical, spherical), equations of lines and planes, second-order curves and surfaces, as well as methods for reducing equations to canonical form; understand the geometric and physical meaning of vector operations, relative positions of lines and planes, properties of second-order curves and surfaces, and their applications in modeling physical and engineering situations[1]
- be able to apply methods of analytic geometry and linear algebra to solve applied problems: computing distances, angles, constructing equations of planes and lines, determining intersection points and the mutual arrangement of geometric objects[2]
- possess skills in analyzing and interpreting mathematical models of spatial objects, using acquired knowledge in mechanics, architecture, and engineering calculations; demonstrate the development of spatial imagination and logical-mathematical thinking required for the subsequent study of fundamental disciplines[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Knowledge of the high school course in mathematical analysis and geometry

**Bibliography**

1. Narmanov A.Ya. Analitik geometriya. T. Innovatsion rivojlantirish nashriyot-matbaa uyi, 2020 y, 160 bet.

2. Моденов П.С. Аналитическая геометрия. М. Изд-во МГУ, 1969.
3. Baxvalov S.V., Modenov P.S., Parxomenko A.S. Analitik geometriyadan masalalar to'plami. T. Universitet, 2006.
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5. Александров П.С. Lectures по аналитической геометрии, пополненные необходимыми сведениями из алгебры с приложением собрания задач. Санкт-Петербург: Лань, 2022.–912с.

## Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| Type of Assessment | CA | FA |
|---|---|---|
| Timing | 13-14 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after mastering sections related to lectures and problem-solving in the amount equal to half of the total. The studied material will be divided into variants, each containing 2 theoretical questions and 1 problem. Answers will be accepted in written form. The student can receive a maximum of 5 points for each correct answer.

**Final Assessment:** conducted based on prepared variants covering all studied topics. Each student receives a variant with 2 theoretical questions and 3 problems on topics studied during the semester. Answers are accepted in written form. The student can receive a maximum of 5 points for each correct answer. The final grade is calculated as the arithmetic mean.

## Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| AAGB112.2 | Linear Algebra and Analytic Geometry 2 (Analytic Geometry) | | |
|---|---|---|---|
| Academic semester | 2 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Dr. Gaybullayev Rustam; Associate Prof., Dr. Normatov Erkin; Associate Prof., Dr. Azizov Azizkhon

**Course content**

Complex numbers and their trigonometric form. De Moivre's formula. Matrices and operations on them. Permutations. Determinants of order *n* and their properties. Algebraic cofactors and minors. Cramer's formulas. Inverse matrix. Linear spaces. Dimension and basis. Theorems on linearly dependent and linearly independent vectors. Rank of a matrix. Complete solution of a system of linear equations. Fundamental solutions of a homogeneous system of equations. Linear subspace. Sum and intersection of subspaces. Euclidean space. Orthogonal and orthonormal systems. Orthogonalization process. Orthogonal complement of a subspace. Quadratic form and its canonical form. Linear transformations and their matrices. Image and kernel of a linear transformation. Relationship between matrices of a linear transformation in different bases. Invariant subspaces. Eigenvalues and eigenvectors of a linear transformation. Adjoint transformation in Euclidean space. Self-adjoint, unitary, and normal transformations.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the basic concepts of analytic geometry and linear algebra: vectors and their products, matrices and determinants, linear spaces and subspaces, eigenvalues and eigenvectors, as well as the structure of complex numbers and their applications; understand the properties and canonical forms of quadratic forms and transformations[1]
- be able to apply methods of linear algebra and analytic geometry to solve systems of linear equations, analyze the relative position of geometric objects, perform computations in various coordinate systems, orthogonalize and diagonalize; use linear transformations and matrix methods to model physical and technical processes[2]
- possess skills in analyzing and interpreting mathematical models, understanding the structure of linear and Euclidean spaces, logical argumentation, and selecting rational methods for problem-solving; demonstrate the development of spatial thinking and abstract modeling necessary for further study of physical and mathematical disciplines and research activities[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Knowledge of the high school course in mathematical analysis and geometry

**Bibliography**

1. Narmanov A.Ya. Analitik geometriya. T. Innovatsion rivojlantirish nashriyot-matbaa uyi,

2020 y, 160 bet.
2. Моденов П.С. Аналитическая геометрия. М. Изд-во МГУ, 1969.
3. Baxvalov S.V., Modenov P.S., Parxomenko A.S. Analitik geometriyadan masalalar to'plami. T. Universitet, 2006.
4. Ильин В.А., Позняк Э.Г. Аналитическая геометрия. М. «Физматлит», 2004.
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## Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| Type of Assessment | CA | FA |
|---|---|---|
| Timing | 31-32 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after mastering sections related to lectures and problem-solving in the amount equal to half of the total. The studied material will be divided into variants, each containing 2 theoretical questions and 1 problem. Answers will be accepted in written form. The student can receive a maximum of 5 points for each correct answer.

**Final Assessment:** conducted based on prepared variants covering all studied topics. Each student receives a variant with 2 theoretical questions and 3 problems on topics studied during the semester. Answers are accepted in written form. The student can receive a maximum of 5 points for each correct answer. The final grade is calculated as the arithmetic mean.

## Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| FPKB124.1 | Physics Laboratory Course 1 (Mechanics) | | |
|---|---|---|---|
| | | | |
| Academic semester | 1 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Laboratory work | 60 h | Preparation for laboratory classes | 30 h |
| | | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Tursunmetov Komil; Associate Prof., Dr. Abdullayev Rakhmatullo; Prof., Dr. Rakhmonov Ganiboy

**Course content**

Safety procedures. Error theory. Experimental procedures. Learning to operate analytical balances. Investigation of the moment of inertia of a wheel. Study of the fundamental law of dynamics for circular motion using an Oberbeck pendulum. Study of the modulus of elasticity under tension. Determination of the modulus of elasticity by bending. Determination of gravitational acceleration using a simple pendulum. Determination of gravitational acceleration using a physical pendulum. Determination of the density of solids by hydrostatic weighing. Determination of the moment of inertia of a body using a trifilar pendulum. Determination of the shear modulus by torsion. Determination of the coefficient of rolling friction between solids by measuring oscillation damping. Study of the motion of Maxwell's pendulum. Determination of the speed of sound in air using the standing wave method. Determination of the dependence of the speed of sound in air on temperature.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the fundamental principles of experimental mechanics, including measurement methods, processing of experimental data, error theory, and principles for constructing physical models of laboratory experiments; understand the physical nature of the phenomena studied in the laboratory course, such as inertia, oscillations, friction, elasticity, sound propagation, etc.[1]
- be able to use laboratory equipment (balances, pendulums, measuring instruments, and setups) to carry out physical measurements and experiments in mechanics; perform calculations based on experimental data, analyze errors, and draw well-founded conclusions; apply theoretical knowledge of mechanics when designing and interpreting physical experiments[2]
- possess skills in preparing laboratory reports, including the presentation of tables, graphs, conclusions, and interpretation of results; demonstrate safe and precise work in laboratory settings, follow instructions, and correctly handle measuring instruments; plan and conduct physical experiments, process data, and present results both orally and in writing[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lab Work; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Basic elements of elementary physics and introductory knowledge of laboratory equipment

**Bibliography**

1. Tursunmetov K.A. Turgunboev F.YU. Xamidjonov I.X. Umumiy fizika kursidan praktikum

"Mexanika" o'quv qo'llanma T.:-2021
2. Tursunmetov K.A., Daliev X.S. Mexanika 1-qism. Toshkent., Universitet 2000
3. Nazirov E.N. va boshqalar. Mexanika va molekulyar fizikadan praktikum. O'zbekiston, T.-2001
4. Tursunmetov K.A. va boshqalar. Umumiy fizika kursidan praktikum. Mexanika. Universitet. T.-1998

## Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 8-9 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

Each laboratory work is assessed on a five-point grading scale. Each student must complete 8 laboratory works during the semester. The final grade is determined as the arithmetic mean of all grades for the laboratory works. The assessment criteria for laboratory works are as follows:

**Mastery Level 5 – "Excellent"**: The student fully understands the topic of the laboratory work and can clearly describe it. Knows the meaning and units of the measured physical quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results without assistance. Is able to provide a well-reasoned and scientifically justified explanation of both the theoretical and practical parts of the report. Presents the theory in full and accurately for all topics related to the laboratory work. Analyzes the advantages and disadvantages of the applied method and calculation technique. Can describe and compare the method used in the laboratory work with alternative methods. Analyzes possible sources of error in obtaining experimental data and provides personal judgments.

**Mastery Level 4 – "Good"**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results. Is able to explain both the theoretical and practical parts of the report logically and independently.

**Mastery Level 3 – "Satisfactory"**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can correctly write down the calculation formulas without derivation. Performs the laboratory work with the help of the instructor or laboratory assistant and correctly calculates the experimental data. In the report, can correctly describe the physical essence of the laboratory work.

**Mastery Level 2 – "Unsatisfactory"**: The student attends the class without any preparation or cannot explain the topic of the laboratory work. Cannot correctly describe the calculation formulas or the measured quantities. Is unable to perform the laboratory work independently. Makes significant errors in the calculation of experimental results. Does not know the principles of error estimation.

## Educational Materials and Media Tools

Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| FPKB124.2 | Physics Laboratory Course 2 (Thermal Physics) | | |
|---|---|---|---|
| | | | |
| Academic semester | 2 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Laboratory work | 60 h | Preparation for laboratory classes | 30 h |
| | | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Tursunmetov Komil; Associate Prof., Dr. Abdullayev Rakhmatullo; Prof., Dr. Rakhmanov Ganiboy

**Course content**

Safety procedures. Error theory. Experimental procedures. Determination of the ratio of specific heat capacities of gases. Determination of the adiabatic index CP/CVC_P/C_VCP/CV for air using the Richard method. Determination of the coefficient of internal friction of air and the mean free path of molecules. Determination of the critical temperature of ether. Observation of the liquid–gas phase transition at the critical point. Determination of the coefficient of internal friction of liquids using Stokes' method. Determination of the coefficient of internal friction of liquids with a capillary viscometer. Determination of the surface tension coefficient of liquids by the ring detachment method. Determination of the surface tension coefficient from the capillary rise height. Determination of the surface tension coefficient by the Rebinder method. Determination of the specific latent heat of vaporization of liquids. Determination of the latent heat of formation of water vapor. Determination of the specific heat capacity of solids and the change in entropy of a real system. Determination of the specific heat capacity of solids. Determination of the specific latent heat of fusion of solids. Measurement of the dependence of the coefficient of linear expansion of solids on temperature. Determination of the coefficient of volumetric expansion of a liquid. Determination of the efficiency of solar collectors as a function of thermal insulation. Study of the dependence of gas pressure on temperature.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the main thermodynamic and molecular-kinetic parameters (heat capacity, viscosity, surface tension, latent heat of phase transitions, etc.) and methods of their experimental determination; understand the physical principles of heat transfer, phase transitions, thermal expansion, and their role in the macroscopic description of matter; be familiar with methods of experimental data processing, rules for error estimation, and principles for plotting physical graphs[1]
- be able to conduct laboratory experiments to determine the thermophysical characteristics of gases, liquids, and solids (including capillary and viscometric methods); process and interpret experimental results, determine physical quantities, and analyze their dependence on environmental parameters (temperature, pressure, etc.); apply theoretical knowledge of Thermal Physics in planning and explaining physical experiments[2]
- possess skills in handling laboratory equipment, including thermometers, viscometers, calorimeters, capillaries, pendulums, and other measuring setups; preparing laboratory reports with graphs, tables, and analysis of experimental errors; safely performing physical experiments in compliance with laboratory regulations and sanitary standards; evaluating the efficiency of thermal devices such as solar collectors based on experimental data[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lab Work; Self-study; Group work;

Admission requirements

Mandatory: No
Recommended: Basic elements of elementary physics and introductory knowledge of laboratory equipment

Bibliography


1. AbdullayevR.M., Sattorov X.K., Tursunmetov K.A. Umumiy fizika kursidan praktikum. Moilekulyar fizika. Toshkent-2011
2. Nazirov E.N. va boshqalar. Mexanika va molekulyar fizikadan praktikum. O‘zbekiston, T.-2001
3. Иверенова Т. ва б. Механика ва молекуляр физикадан практикум. O‘qituvchi


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

Each laboratory work is assessed on a five-point grading scale. Each student must complete 8 laboratory works during the semester. The final grade is determined as the arithmetic mean of all grades for the laboratory works. The assessment criteria for laboratory works are as follows:

**Mastery Level 5 – "Excellent"**: The student fully understands the topic of the laboratory work and can clearly describe it. Knows the meaning and units of the measured physical quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results without assistance. Is able to provide a well-reasoned and scientifically justified explanation of both the theoretical and practical parts of the report. Presents the theory in full and accurately for all topics related to the laboratory work. Analyzes the advantages and disadvantages of the applied method and calculation technique. Can describe and compare the method used in the laboratory work with alternative methods. Analyzes possible sources of error in obtaining experimental data and provides personal judgments.

**Mastery Level 4 – "Good"**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results. Is able to explain both the theoretical and practical parts of the report logically and independently.

**Mastery Level 3 – "Satisfactory"**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can correctly write down the calculation formulas without derivation. Performs the laboratory work with the help of the instructor or laboratory assistant and correctly calculates the experimental data. In the report, can correctly describe the physical essence of the laboratory work.

**Mastery Level 2 – "Unsatisfactory"**: The student attends the class without any preparation or cannot explain the topic of the laboratory work. Cannot correctly describe the calculation formulas or the measured quantities. Is unable to perform the laboratory work independently. Makes significant errors in the calculation of experimental results. Does not know the principles of error estimation.

Educational Materials and Media Tools

Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| FPKB124.3 | Physics Laboratory Course 3 (Electricity and Magnetism) | | |
|---|---|---|---|
| | | | |
| Academic semester | 3 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Laboratory work | 60 h | Preparation for laboratory classes | 30 h |
| | | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Rakhmanov Ganiboy; Associate Prof., Dr. Nurmatov Nebodir; Dr. Kosberganov Ernazar;

**Course content**

Safety procedures. Error theory. Experimental procedures. Measurement of resistances using an AC bridge. Investigation of an electrostatic field. Measurement of the force acting on a current-carrying conductor in a stationary magnetic field. Determination of capacitor capacitance by the bridge method. Study of the volt–ampere characteristic of a vacuum diode. Measurement of the magnetic field of an inductive coil without a magnetic core. Study of the charging and discharging processes of capacitors. Verification of Ohm's law for alternating current. Determination of the horizontal component of the Earth's magnetic field. Measurement of the internal resistance of a galvanometer using a DC bridge method. Determination of the electrochemical equivalent of copper.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the physical nature of electric and magnetic fields, their behavior in steady-state and alternating modes; the operating principles and characteristics of basic electrical and magnetic instruments, such as galvanometers, diodes, inductive coils, capacitors, and AC/DC bridges; methods of measuring electrical quantities (voltage, current, resistance, electromagnetic induction) and the appropriate experimental techniques[1]
- be able to perform laboratory work on investigating electrostatic and magnetic fields, DC and AC circuits; analyze and interpret volt–ampere characteristics, capacitor charging and discharging processes, and electromagnetic effects in conductors; use bridge circuits for precise measurements of electrical parameters, including resistance, capacitance, and the internal resistance of sources[2]
- possess skills in the safe and accurate execution of physical experiments with electrical circuits and magnetic system components; plotting graphs and processing experimental data, including error evaluation and drawing well-founded conclusions; independently carrying out measurements, working with measuring instruments, and preparing laboratory reports; applying the physical laws of electricity and magnetism to solve practical problems[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lab Work; Self-study; Group work;

**Admission requirements**

Mandatory: No

Recommended: Basic elements of elementary physics and introductory knowledge of laboratory equipment

**Bibliography**

1. Nurmatov N.A., Raxmonov G'.T., Sultonov O.Z., Alimov R., Xamidjonov I.X. Elektr va

magnetizm fanidan fizpraktikum. Toshkent. Universitet – 2021.
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Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 8-9 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

Each laboratory work is assessed on a five-point grading scale. Each student must complete 8 laboratory works during the semester. The final grade is determined as the arithmetic mean of all grades for the laboratory works. The assessment criteria for laboratory works are as follows:

**Mastery Level 5 – "Excellent"**: The student fully understands the topic of the laboratory work and can clearly describe it. Knows the meaning and units of the measured physical quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results without assistance. Is able to provide a well-reasoned and scientifically justified explanation of both the theoretical and practical parts of the report. Presents the theory in full and accurately for all topics related to the laboratory work. Analyzes the advantages and disadvantages of the applied method and calculation technique. Can describe and compare the method used in the laboratory work with alternative methods. Analyzes possible sources of error in obtaining experimental data and provides personal judgments.

**Mastery Level 4 – "Good"**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results. Is able to explain both the theoretical and practical parts of the report logically and independently.

**Mastery Level 3 – "Satisfactory"**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can correctly write down the calculation formulas without derivation. Performs the laboratory work with the help of the instructor or laboratory assistant and correctly calculates the experimental data. In the report, can correctly describe the physical essence of the laboratory work.

**Mastery Level 2 – "Unsatisfactory"**: The student attends the class without any preparation or cannot explain the topic of the laboratory work. Cannot correctly describe the calculation formulas or the measured quantities. Is unable to perform the laboratory work independently. Makes significant errors in the calculation of experimental results. Does not know the principles of error estimation.

Educational Materials and Media Tools

Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| FPKB124.4 | Physics Laboratory Course 4 (Optics) | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 4 |
| | | | |
| Academic workload | | | |
| Contact hours | | Independent work | |
| Laboratory work | 60 h | Preparation for laboratory classes | 30 h |
| | | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |
| Lecturers | | | |
| Prof., Dr. Otajonov Shavkat; Associate Prof., Dr. Malisheva Mariya | | | |
| Course content | | | |
| Safety procedures. Error theory. Experimental procedures. Spherical aberration of lenses. Determination of the focal length of converging and diverging lenses. Newton's experiment on splitting white light into a spectrum and recombining it into white light. Diffraction of light in a secondary slit. Recording and analysis of results using VideoCom. Investigation of interference phenomena in a Fresnel mirror using a helium–neon laser. Transmitted and reflected Newton's rings in white light. Determination of the refractive index of gases using a Rayleigh interferometer. Measurement of the refractive index of air using a Mach–Zehnder interferometer. Determination of the radius of curvature of a lens using Newton's rings. Determination of the wavelength of helium–neon laser radiation using a Michelson interferometer. Determination of the wavelength of light using a diffraction grating. Determination of the refractive index and dispersion of liquids using an Abbe refractometer. Creation of a hologram using transmitted laser light. Fresnel's law of reflection. Quarter-wave and half-wave plates. Rotation of the plane of polarization in sugar solutions. Study of optical activity in a magnetic field. Stefan–Boltzmann law. Determination of the dependence of blackbody radiation intensity on temperature. Investigation of the line spectra of inert gases and metal vapors using a prism spectrometer. Determination of refractive index and dispersion of liquids. Assembly of a diffraction spectrometer for measuring spectral lines. Investigation of the absorption spectrum of a colored liquid. Study of the hydrogen spectrum. Determination of the Rydberg constant. Alignment of a styloscope and determination of the wavelengths of neon and mercury spectra. Dependence of light scattering intensity in a medium on wavelength. Verification of Rayleigh's law. Determination of the spectral characteristics of a diffraction grating using an optical spectrum analyzer. Determination of microscope magnification and its use in measuring the refractive index of a glass plate. Polarized beams. Study of Malus' law. Investigation of polarization plane rotation using a saccharimeter. | | | |
| Learning objectives | | | |
| Upon successful completion of this course, students should be able to:<br>• know the fundamental physical phenomena and laws of geometrical and wave optics: refraction, reflection, interference, diffraction, dispersion, and polarization of light; the operating principles and applications of optical instruments such as spectrometers, interferometers, refractometers, polarimeters, and holographic setups; experimental methods for determining focal lengths of lenses, refractive indices, light wavelengths, intensities, and spectral characteristics[1]<br>• be able to conduct experiments on interference (Fresnel mirror, Newton's rings, Michelson and Mach–Zehnder interferometers) and diffraction (slit, grating, spectrometer); apply optical measurement methods to determine physical characteristics of different media and substances; work with polarized light, including studying Malus' law, polarization plane rotation, and using wave plates; perform spectroscopic studies and analyze spectra of hydrogen, inert gases, metals, and colored liquids[2] | | | |

- possess skills for safe and accurate execution of optical experiments using lasers, lenses, interferometers, spectrometers, and other instruments; process and analyze experimental data with error consideration, plot graphs, calculate physical parameters, and prepare reports; work with modern digital tools for recording and analyzing optical phenomena (video recording, data analysis software); apply optics knowledge to solve practical problems in photonics, optoelectronics, metrology, and other scientific and engineering fields[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Lab Work; Self-study; Group work;

Admission requirements

Mandatory: No
Recommended: Basic elements of elementary physics and introductory knowledge of laboratory equipment

Bibliography


1. «Fizikadan praktikum». Elektr va optika. Iveronova taxriri ostida. T.1968
2. Ландсберг Г.С. "Оптика" Т 1981.
3. Калитеевский Н.И. "Волновая оптика" М.1971. М. 2006.
4. Karimov R., Otajonov Sh., Эshjanov B., I.Buribaev Optikadan masalalar va laboratoriya ishlari to'plami O'quv qo'llanma, Toshkent, 2016.
5. Otajonov Sh, Ramazanov A.X., S.Reymbayeva va boshqalar Optika fani bo'yicha laboratoriya ishlarining uslubiy qo'llanmasi. O'zMU Toshkent-2019, 108 bet.


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

Each laboratory work is assessed on a five-point grading scale. Each student must complete 8 laboratory works during the semester. The final grade is determined as the arithmetic mean of all grades for the laboratory works. The assessment criteria for laboratory works are as follows:

**Mastery Level 5 – "Excellent"**: The student fully understands the topic of the laboratory work and can clearly describe it. Knows the meaning and units of the measured physical quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results without assistance. Is able to provide a well-reasoned and scientifically justified explanation of both the theoretical and practical parts of the report. Presents the theory in full and accurately for all topics related to the laboratory work. Analyzes the advantages and disadvantages of the applied method and calculation technique. Can describe and compare the method used in the laboratory work with alternative methods. Analyzes possible sources of error in obtaining experimental data and provides personal judgments.

**Mastery Level 4 – "Good"**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results. Is able to explain both the theoretical and practical parts of the report logically and independently.

**Mastery Level 3 – "Satisfactory"**: The student understands the topic of the laboratory work

| |
|---|
| and can describe it. Knows the meaning and units of the measured quantities. Can correctly write down the calculation formulas without derivation. Performs the laboratory work with the help of the instructor or laboratory assistant and correctly calculates the experimental data. In the report, can correctly describe the physical essence of the laboratory work.<br>**Mastery Level 2 – "Unsatisfactory"**: The student attends the class without any preparation or cannot explain the topic of the laboratory work. Cannot correctly describe the calculation formulas or the measured quantities. Is unable to perform the laboratory work independently. Makes significant errors in the calculation of experimental results. Does not know the principles of error estimation. |
| Educational Materials and Media Tools |
| Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials |

| FPKB124.5 | Physics Laboratory Course 5 (Atomic Physics) | | |
|---|---|---|---|
| | | | |
| Academic semester | 5 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Laboratory work | 60 h | Preparation for laboratory classes | 30 h |
| | | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof. Polvonov Sotimboy; Associate Prof. Mamayusupova Mukaddas

**Course content**

Safety procedures. Error theory. Experimental procedures. Franck–Hertz experiment with mercury – measurement and analysis using a Cassy system. Determination of Planck's constant using a compact measuring device. Nuclear magnetic resonance in polystyrene, glycerin, and Teflon. Determination of wavelengths Hα, Hβ, and Hγ from the Balmer series of hydrogen. Determination of the specific charge of the electron. Study of the laws of the photoelectric effect. Determination of the Stefan–Boltzmann constant.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the fundamentals of atomic and nuclear physics, including the structure of the atom, energy levels, the laws of the photoelectric effect, nuclear magnetic resonance, and thermal radiation; principles and physical interpretation of the Franck–Hertz experiment, photoelectric effect, determination of Planck's constant, nuclear magnetic resonance, hydrogen spectra, and the specific charge of the electron; methods for experimentally determining fundamental physical constants such as Planck's constant, the specific charge of the electron, and the Stefan–Boltzmann constant[1]
- be able to conduct the Franck–Hertz experiment and analyze data to evaluate the energy levels of an atom; perform wavelength measurements of hydrogen lines from the Balmer series and determine the Rydberg constant; use nuclear magnetic resonance to study the physical properties of different substances; carry out photoelectric effect experiments and calculate Planck's constant, as well as analyze the dependence of the kinetic energy of photoelectrons on the radiation frequency; apply thermoradiative measurement methods to assess thermal radiation parameters and determine the Stefan–Boltzmann constant[2]
- possess skills for safe and precise execution of laboratory work in atomic physics, following safety rules and electrical equipment handling procedures; statistical processing of experimental data, error analysis, graph plotting, and examination of physical patterns; operation of modern laboratory equipment, including digital and compact measuring devices; integration of theoretical knowledge in atomic physics with experimental results to interpret physical processes at the microscopic level[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lab Work; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Basic elements of elementary physics and introductory knowledge of laboratory equipment

**Bibliography**

1. Polvonov S.R., Ruzimov Sh.M., Mamajusupova M.I. Atom va yadro fizikasidan laboratoriya ishlari. T. “UNIVERSITET”, 2020. - 120 b.
2. Kanokov Z., Karaxodjayev A.K., Nasriddinov K.R., Polvnov S.R. Atom va yadro fizikasidan laboratoriya ishlari. Universitet. T.-2002.-148 b.
3. Бояркина А.Н., Гончарова Н.Г. Практикум по ядрной физике. М.: Изд-во Московского университета, 1988. - 199 с.
4. Polvonov S.R., Kanokov Z., Ruzimov Sh.M. Atom va yadro fizikasidan masalalar to`plami. T. “UNIVERSITET”, 2017. - 200 b.

## Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 8-9 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

Each laboratory work is assessed on a five-point grading scale. Each student must complete 8 laboratory works during the semester. The final grade is determined as the arithmetic mean of all grades for the laboratory works. The assessment criteria for laboratory works are as follows:

**Mastery Level 5 – “Excellent”**: The student fully understands the topic of the laboratory work and can clearly describe it. Knows the meaning and units of the measured physical quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results without assistance. Is able to provide a well-reasoned and scientifically justified explanation of both the theoretical and practical parts of the report. Presents the theory in full and accurately for all topics related to the laboratory work. Analyzes the advantages and disadvantages of the applied method and calculation technique. Can describe and compare the method used in the laboratory work with alternative methods. Analyzes possible sources of error in obtaining experimental data and provides personal judgments.

**Mastery Level 4 – “Good”**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results. Is able to explain both the theoretical and practical parts of the report logically and independently.

**Mastery Level 3 – “Satisfactory”**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can correctly write down the calculation formulas without derivation. Performs the laboratory work with the help of the instructor or laboratory assistant and correctly calculates the experimental data. In the report, can correctly describe the physical essence of the laboratory work.

**Mastery Level 2 – “Unsatisfactory”**: The student attends the class without any preparation or cannot explain the topic of the laboratory work. Cannot correctly describe the calculation formulas or the measured quantities. Is unable to perform the laboratory work independently. Makes significant errors in the calculation of experimental results. Does not know the principles of error estimation.

## Educational Materials and Media Tools

Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| FPKB124.6 | Physics Laboratory Course 6<br>(Nuclear and Elementary Particles Physics) | | |
|---|---|---|---|
| | | | |
| Academic semester | 6 | ECTS | 4 |
| | | | |
| Academic workload | | | |
| Contact hours | | Independent work | |
| Laboratory work | 60 h | Preparation for laboratory classes | 30 h |
| | | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |
| Lecturers | | | |
| Prof. Polvonov Sotimboy; Associate Prof. Mamayusupova Mukaddas | | | |
| Course content | | | |
| Safety procedures. Error theory. Experimental procedures. Investigation of the dependence of beta radiation intensity on distance. Determination of the half-life of the radioisotope cesium-137. Study of the statistical nature of nuclear processes. Determination of the activity of a beta-radioactive source. Determination of the half-life of a long-lived radioactive isotope. Study of the composition of cosmic rays. Fundamentals of dosimetry. | | | |
| Learning objectives | | | |
| Upon successful completion of this course, students should be able to:<br>• know the main characteristics of nuclear radiation (alpha, beta, and gamma radiation), the nature of radioactive decay, and the principles of nuclear stability; the physical foundations of nuclear processes, including the law of radioactive decay, half-life, the concept of activity, and the statistical nature of radioactivity; the design and operating principles of detectors and measuring devices used in nuclear physics and dosimetry[1]<br>• be able to measure and analyze the dependence of beta radiation intensity on the distance from the source; determine the half-life of radioisotopes such as Cs-137 using experimental methods and statistical data processing; calculate the activity of a radioactive source from measurement results; conduct experiments to study cosmic rays and analyze the obtained results; apply basic dosimetry methods to assess ionizing radiation levels[2]<br>• possess skills for the safe handling of radioactive sources and the use of personal protective equipment; accurate measurement, recording, and statistical processing of nuclear data; operation of laboratory equipment for detecting and analyzing elementary particles and nuclear processes; integration of experimental data with theoretical models of radioactive decay and radiation–matter interaction[3]<br><br>[1] knowledge; [2] skills; [3] abilities; | | | |
| Teaching and learning methods | | | |
| Lab Work; Self-study; Group work; | | | |
| Admission requirements | | | |
| Mandatory: No<br>Recommended: basic elements of elementary physics and introductory knowledge of laboratory equipment | | | |
| Bibliography | | | |
| 1. Polvonov S.R., Ruzimov Sh.M., Mamajusupova M.I. Atom va yadro fizikasidan laboratoriya ishlari. T. “UNIVERSITET”, 2020. - 120 b.<br>2. Kanokov Z., Karaxodjayev A.K., Nasriddinov K.R., Polvnov S.R. Atom va yadro fizikasidan laboratoriya ishlari. Universitet. T.-2002.-148 b.<br>3. Бояркина А.Н., Гончарова Н.Г. Практикум по ядрной физике. М.: Изд-во Московского | | | |

университета, 1988. - 199 с.
4. Polvonov S.R., Kanokov Z., Ruzimov Sh.M. Atom va yadro fizikasidan masalalar to`plami. T. “UNIVERSITET”, 2017. - 200 b.

Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

Each laboratory work is assessed on a five-point grading scale. Each student must complete 8 laboratory works during the semester. The final grade is determined as the arithmetic mean of all grades for the laboratory works. The assessment criteria for laboratory works are as follows:

**Mastery Level 5 – “Excellent”**: The student fully understands the topic of the laboratory work and can clearly describe it. Knows the meaning and units of the measured physical quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results without assistance. Is able to provide a well-reasoned and scientifically justified explanation of both the theoretical and practical parts of the report. Presents the theory in full and accurately for all topics related to the laboratory work. Analyzes the advantages and disadvantages of the applied method and calculation technique. Can describe and compare the method used in the laboratory work with alternative methods. Analyzes possible sources of error in obtaining experimental data and provides personal judgments.

**Mastery Level 4 – “Good”**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can derive the calculation formula and correctly interpret it. Performs the laboratory work independently and calculates the results. Is able to explain both the theoretical and practical parts of the report logically and independently.

**Mastery Level 3 – “Satisfactory”**: The student understands the topic of the laboratory work and can describe it. Knows the meaning and units of the measured quantities. Can correctly write down the calculation formulas without derivation. Performs the laboratory work with the help of the instructor or laboratory assistant and correctly calculates the experimental data. In the report, can correctly describe the physical essence of the laboratory work.

**Mastery Level 2 – “Unsatisfactory”**: The student attends the class without any preparation or cannot explain the topic of the laboratory work. Cannot correctly describe the calculation formulas or the measured quantities. Is unable to perform the laboratory work independently. Makes significant errors in the calculation of experimental results. Does not know the principles of error estimation.

Educational Materials and Media Tools

Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| MOLB1061 | Thermal Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 2 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 60 h | Preparation for classes | 30 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 90 h | Total | 90 h |
| Total work-load | 180 h | | |

**Lecturers**

Prof., Dr. Tursunmetov Komil; Prof., Dr. Rakhmanov Ganiboy; Associate Prof., Dr. Abdullayev Rakhmatullo;

**Course content**

Introduction. Development of molecular-kinetic concepts of matter and models of its structure in classical and quantum physics. Properties of matter. Pressure of an ideal gas. Temperature. Laws of an ideal gas. Barometric formula. Probability. Distribution function. Distribution of molecules by velocities. Maxwell distribution of relative velocities. Experimental verification of the distribution law. Internal energy of an ideal gas. Heat capacity of ideal gases. Heat capacity of gases. Diatomic and polyatomic gases. Work during changes in gas volume. Molecular motion and transport phenomena. Non-stationary and stationary diffusion. Thermal conductivity. Viscosity. Intermolecular forces. Equation of state for a real gas. Phase transitions. Critical state and critical parameters. Reduced Van der Waals equation. Reversible and irreversible processes. Entropy. Entropy and probability. Bulk properties of liquids. Crystal lattice and its types.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the fundamental principles of molecular-kinetic theory and thermodynamics; the nature of macroscopic properties of substances determined by microscopic structure; the physical meaning and application of the equation of state, transport coefficients, thermodynamic parameters and laws; the structural features and properties of ideal and real gases, liquids, and solids, including crystalline structures and their anisotropy[1]
- be able to apply fundamental laws and equations (equation of state, first and second laws of thermodynamics, etc.) to analyze and calculate state parameters, heat transfer, work, and internal energy in various physical processes; perform laboratory work on the topic, use measuring instruments, conduct observations and calculations taking into account measurement uncertainties[2]
- have skills in physical modeling of heat transfer processes and molecular interactions, processing experimental data and interpreting results; explaining the physical meaning of observed phenomena (viscosity, thermal conductivity, surface tension, phase transitions, etc.); generalizing results obtained and formulating conclusions on the consistency of experimental results with theoretical models[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Knowledge of the basic elements of Thermal Physics included in the elementary physics course

Bibliography


1. Kikoin A.K., Kikoin I.K. Umumiy fizika kursi. Molekulyar fizika, O‘qituvchi, Toshkent-2004.
2. Jearl Walker, David Hallidey., R.Resnick. Fundamentals of physics. ISBN 978-8808-08797-3. 2014.
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5. Sivuxin D.V. Umumiy fizika kursi. Termodinamika va molekulyar fizika. O‘qituvchi. Toshkent-1984, 526 bet.
6. Chertov A.A., Vorobyev A. Umumiy fizika kursidan masalalar to‘plami. Toshkent, O‘qituvchi, 1988 y.
7. Sedrik M.S. Umumiy fizika kursidan masalalar to‘plami. Toshkent, O‘qituvchi, 1991
8. Karabayeva M.A. Molekulyar fizika. T. Universitet-2014. 298 b


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** carried out after completion of sections related to lectures and problem-solving, covering half of the total material. The studied material is divided into variants, each containing 3 theoretical questions and 1 problem. Answers are accepted in written form. A student can receive a maximum of 5 points for each correct answer.
**Final Assessment:** carried out based on compiled variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. After submitting the written answers, the student then answers the questions orally and can receive a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| FJKB2061 | Computer Modeling of Physical Processes | | |
|---|---|---|---|
| | | | |
| Academic semester | 3 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Associate Prof. Dr. Akhmadjanov Turgunali; Dr. Akramov Mashrab; Prof., Dr. Akhunov Talat

**Course content**

Introduction. Installing the Python programming environment. Configuration and use of the Python programming environment. Study of linear algorithms in Python. Branching algorithms. Arrays and algorithms associated with them. Methods. Basics of Object-Oriented Programming (OOP). Classes and objects. Dynamic creation of objects. Window-related events. Solving mathematical equations in Python. Working with arrays of random numbers. Solving problems of function construction. Numerical solution of ordinary differential equations. Modeling free fall. Modeling the motion of a body thrown at an angle to the horizon. Modeling uniformly accelerated motion. Oscillatory processes. Random processes. Fourier transform on the computer.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the principles and stages of constructing computational models of physical processes; the role of programming and numerical modeling in physics and scientific research; the transition from physical phenomena to mathematical and computer models; limitations, assumptions, and interpretations within modeling[1]
- be able to develop and implement simple numerical models of physical systems using programming languages and specialized software; apply algorithms for numerical integration, approximation, and solving differential equations; visualize and interpret modeling results[2]
- have skills in analyzing the results of numerical experiments, evaluating the stability and accuracy of models, identifying and interpreting possible sources of error; adapting models to changing parameters, boundary conditions, or physical problems; formulating well-grounded conclusions about the behavior of simulated systems and correlating numerical results with experimental and theoretical data[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem Solving; Self-study; Group work;

**Admission requirements**

Mandatory: Basic knowledge of elementary physics across all sections; mathematical analysis and differential equations.
Recommended: Basics of programming languages such as Python, C#, or others; Informatics and Information Technologies.

**Bibliography**


1. Harvey Gould, Jan Tobochnik, Wolfgang Christian. “An introduction to computer simulation methods. Applications to Physical Systems”. Pearson Education, Inc., publishing as Addison Wesley, 2007.
2. Х. Гулд, Я. Тобочник. Компьютерное моделирование в физике. М.: Мир, 1990.

3. Н.Н. Мирошниченко, Н.Г. Пономарёв. Программирование на языке C#. – Х. : НТУ «ХПИ», 2016. – 356 с.

Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 8-9 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** carried out after the completion of sections related to lectures and problem-solving, covering half of the total material. The studied material is divided into variants, each containing 3 practical tasks. These tasks must be solved directly on the computer. A student can receive a maximum of 5 points for each correct solution.

**Final Assessment:** carried out based on compiled variants covering all studied topics. Each student receives a variant containing 3 practical tasks. These tasks must be solved directly on the computer. Within 2 hours, the student writes the corresponding programs, which must provide correct answers for the given test initial conditions. A student can receive a maximum of 5 points for each correct solution. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Personal computers; Projector; white/black board; printed handouts; visual aids for presentations;

| DFTB206 | Differential Equations | | |
|---|---|---|---|
| | | | |
| Academic semester | 3 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Associate Prof. Dr. Fayziyev Yusuf; Associate Prof. Dr. Buvayev Kakhramon; Dr. Sheraliyev Shukhrat

**Course content**

Concept of Differential Equations. Homogeneous differential equations with separable variables. Differential equations reducible to homogeneous differential equations. First-order linear differential equations. Exact differential equations. Non-solvable differential equations with respect to the derivative. Higher-order differential equations. Higher-order linear differential equations. Linear homogeneous differential equations with constant coefficients. Linear homogeneous differential equations with variable coefficients. Systems of differential equations. Systems of linear differential equations with constant coefficients. Systems of linear homogeneous differential equations with constant coefficients. First-order partial differential equations.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the main concepts and classification of differential equations (by order, type, linearity, presence of variable coefficients); analytical solution methods (separation of variables, integrating factor, variation of parameters, etc.); formulas for solving linear equations and systems, as well as standard equations in physics[1]
- be able to apply solution methods for ordinary differential equations and some partial differential equations to analyze and describe the dynamics of physical processes; derive and interpret differential equations arising in problems of mechanics, electrodynamics, oscillations, and heat transfer; use analytical and numerical methods in solving practice-oriented problems[2]
- have skills in qualitative analysis of solutions (stability, behavior under changing parameters and initial conditions); generalizing known methods to new problems; comparing mathematical solutions with physical models; developing mathematical modeling in applied contexts, taking into account limitations and assumptions[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem Solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Mathematical analysis, linear algebra, and analytical geometry

**Bibliography**


1. Guter R.S., Yanpolskiy A.R. Differensial tenglamalar. O‘qituvchi nashriyoti, Toshkent 1978.
2. Boyqo‘ziev Q.B. Differensial tenglamalar. O‘qituvchi nashriyoti, Toshkent 1978.
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4. Филиппов А.Ф. Сборник задач по дифференциальным уравнениям. Научно-издательский центр ”Регулярная и хаотическая динамика”, Москва 2000.

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Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 8-9 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** carried out after completion of sections related to lectures and problem-solving, covering half of the total material. The studied material is divided into variants, each containing 3 theoretical questions and 1 problem. Answers are accepted in written form. A student can receive a maximum of 5 points for each correct answer.
**Final Assessment:** carried out based on compiled variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. After submitting the written answers, the student then answers the questions orally and can receive a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| ELMB206 | Electricity and Magnetism | | |
|---|---|---|---|
| | | | |
| Academic semester | 3 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 60 h | Preparation for classes | 30 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 90 h | Total | 90 h |
| Total work-load | 180 h | | |

**Lecturers**

Associate Prof., Dr. Nurmatov Nebodir; Senior Lecturer Uralov Ikrom; Dr. Kosberganov Ernazar; Prof., Dr. Rakhmonov Ganiboy

**Course content**

Introduction. The electric field and its main characteristics. Electric displacement vector. Gauss's theorem. Work performed in an electrostatic field. General problem of electrostatics. Conductors in an electric field. Dielectrics in an electric field. Electric susceptibility and dielectric permittivity. Direct electric current. Ohm's laws. Branched circuits. Kirchhoff's rules. Work and power of electric current. Nature of electrical conductivity in metals. Classical electron theory of conductivity. Electric current in vacuum. Semiconductors and their conductivity. Magnetic field of direct current. Magnetic field of currents. Magnetic field of parallel currents. Magnetic phenomena. Diamagnetics and paramagnetics. Ferromagnetics. Magnetic circuits. Electromagnetic induction. Energy of the magnetic field. Electromagnetic oscillations. Alternating current. Electromagnetic field. Electromagnetic waves.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the main physical quantities and concepts describing electric and magnetic fields (intensity, potential, current, voltage, resistance, induction, etc.); the fundamental laws of classical electrodynamics (Coulomb, Ohm, Kirchhoff, Gauss, Ampere, Faraday, Biot–Savart–Laplace) and the physical foundations of the interactions of charges and currents with fields[1]
- be able to apply physical laws to analyze and calculate electric and magnetic fields, direct and alternating current circuits, including transient processes, resonance, and reactive power; perform calculations of parameters and characteristics of electric circuits; conduct laboratory experiments, measure and interpret results, and determine errors[2]
- have skills in constructing and investigating electrical models, processing experimental data, and explaining electromagnetic phenomena on the basis of physical principles; generalizing theoretical and practical results for assessing the validity of models, reliability of measurements, and understanding the applicability of electrodynamics laws in engineering and applied tasks[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: основные элементы элементарной физики

**Bibliography**


1. Kalashnikov S.G. Umumiy fizika kursi. Elektr (lotin grafikasida). Oliy o'quv yurtlarining fizika ixtisosi bo'yicha o'quv qo'llanma. Universitet.Toshkent-2022.
2. Jearl Walker, David Hallidey., R.Resnick. Fundamentals of physics. ISBN 978-8808-08797-3.

2014.
3. Сивухин Д.В. Курс общей физики. т.Ш, Электричество, Учебное пособие для студентов физических специальностей высших учебных заведений. Наука, М.-2004.
4. Douglas C. Giancoli. Physic sprinciples withapplications. 2014
5. Sedrik M.S. Umumiy fizika kursidan masalalar to‘plami. Toshkent, O‘qituvchi, 1991

Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 8-9 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** carried out after completion of sections related to lectures and problem-solving, covering half of the total material. The studied material is divided into variants, each containing 3 theoretical questions and 1 problem. Answers are accepted in written form. A student can receive a maximum of 5 points for each correct answer.
**Final Assessment:** carried out based on compiled variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. After submitting the written answers, the student then answers the questions orally and can receive a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| OPTB206 | Optics | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 5 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 60 h | Preparation for classes | 30 h |
| Problem solving | 30 h | Literary Studies | 30 h |
| | | Preparation of a coursework project | 30 h |
| Total | 90 h | Total | 90 h |
| Total work-load | 180 h | | |

**Lecturers**

Prof., Dr. Otajonov Shavkat; Prof., Dr. Eshchanov Boxodir; Associate Prof., Dr. Saparbayev Aziz; Associate Prof., Associate Prof., Dr. Malisheva Mariya;

**Course content**

Introduction. The significance of optics within the structure of physics and its role in the study of other natural sciences. Electromagnetic waves, their properties, Maxwell's theory. Plane electromagnetic wave. Energy of electromagnetic radiation. Umov–Poynting vector. Propagation, refraction, and reflection of electromagnetic waves at the boundary between two media, Fermat's principle. Fresnel equations for natural and polarized light. Total internal reflection at the boundary of two media, optical (fiber) communication. Dispersion of light: normal and anomalous dispersion. Light absorption, Beer–Lambert–Bouguer law. Phase and group velocities of light. Interference of light. Methods of producing interference: Young's experiment. Methods of producing interference: interference of transmitted and reflected beams, Newton's rings. Practical applications of interference, interferometers. Diffraction of light: Huygens–Fresnel principle, Fresnel zones. Diffraction on slits and obstacles of various forms. Fraunhofer diffraction. Practical applications of diffraction phenomena. Spectral instruments with diffraction gratings and prisms. Polarization of light, Malus's law. Crystal optics. Generation and properties of linearly, elliptically, and circularly polarized light. Artificial optical anisotropy. Thermal radiation, Kirchhoff's laws. Radiation of a blackbody: Stefan–Boltzmann and Wien's laws. Planck's theory. Corpuscular properties of light. External and internal photoelectric effect. Properties of media and molecules. Light scattering in media. Light sources, requirements for light sources in optical research.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the fundamental concepts and laws of geometrical, wave, and quantum optics: the nature of light as both an electromagnetic wave and a quantum, Maxwell's equations, the laws of reflection and refraction, interference, diffraction, polarization, thermal radiation, as well as the operating principles of basic optical instruments[1]
- be able to apply optical laws and equations to analyze and calculate phenomena such as interference and diffraction patterns, light parameters in various media, thermal radiation, and light propagation in optical systems; use experimental methods and instruments for studying optical effects, processing, and interpreting data[2]
- have skills in analyzing optical phenomena from both classical and quantum perspectives; generalizing and comparing experimental results with theoretical calculations; assessing the applicability of optical models to real conditions; drawing conclusions about the physical properties of media and wave process parameters based on optical observations[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

| Admission requirements |
|---|
| Mandatory: Basic elements of optics from elementary physics, mathematical analysis, differential equations, electricity and magnetism.<br>Recommended: Informatics and Information Technology, Thermal Physics |
| **Bibliography** |
| 1. Ландсберг Г.С. "Оптика" Т 1981.<br>2. Калитеевский Н. И. “Волновая оптика” М.1971. М. 2006.<br>3. Сивухин Д.В. «Оптика» «Физмат» М. 2005.<br>4. Qo‘yliev B.T. Optika, “Fan va texnologiya” T. 2014.<br>5. Sodiqova Sh., Otajonov Sh., Kurbanov M. “Lazerlar va ularning amaliyotdagi o‘rni”. “Fan va texnologiya”,Toshkent, 2019. |
| **Assessments** |
| Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.<br><br>**Type of Assessment** — **CA**: Timing: 27-28 th week; Form of Assessment: written exam — **FA**: Timing: 36-37 th week; Form of Assessment: written and oral exam<br><br>**Continuous Assessment:** carried out after completion of sections related to lectures and problem-solving, covering half of the total material. The studied material is divided into variants, each containing 3 theoretical questions and 1 problem. Answers are accepted in written form. A student can receive a maximum of 5 points for each correct answer.<br>**Final Assessment:** carried out based on compiled variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. After submitting the written answers, the student then answers the questions orally and can receive a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean. |
| **Educational Materials and Media Tools** |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| NZMB206 | Theoretical Mechanics | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Лектор**

Associate Prof., Dr. Karimkhodjayev Abdugapur; Associate Prof., Dr. Rakhmatov Azam; Senior Lecturer Eshimbetov Uktam

**Course content**

Lagrangian Formalism. Lagrangian function. Concept of action. Principle of least action. Symmetry of space and time. Inertial reference frames. Galileo's principle of relativity. Conservation laws. Integrals of motion. Symmetry of space and time and conservation laws. Integration of equations of motion, graphical analysis. Integration of one-dimensional motion. Motion in a central field, graphical analysis, integrals of motion. Kepler's laws. Particle collisions. Spontaneous particle decay and elastic collisions. Concept of effective scattering cross-section. Rutherford formula. Small oscillations. Stable (equilibrium) position. One-dimensional free and forced oscillations. Resonance. Oscillations of a system with several degrees of freedom. Concept of normal coordinates. Damped oscillations. Forced oscillations with damping. Nonlinear oscillations. Canonical equations. Hamiltonian function. Hamilton's canonical equations. Poisson brackets. Canonical transformations. Finding and types of canonical transformations. Types of generating functions. Hamilton–Jacobi method and its equation. Method of separation of variables. Action–angle variables and adiabatic invariants. Motion of a rigid body. Angular velocity. Angular momentum and energy of a rigid body. Inertia tensor. Equations of motion of a rigid body. Euler angles. Euler's equations. Motion in non-inertial reference frames.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the fundamental principles and equations of theoretical mechanics: Newton's laws, Lagrangian and Hamiltonian formalisms, principle of least action, equations of motion in central and Coulomb fields, Euler's equations for rigid bodies, Poisson brackets, canonical transformations, conservation of momentum, energy, and angular momentum, normal coordinates, and small oscillations[1]
- be able to apply the formalisms of Lagrange, Hamilton, and Hamilton–Jacobi to derive equations of motion; solve problems using the principle of least action and conservation laws; analyze motion in central fields; perform expansions for small oscillations; find normal coordinates; calculate rigid-body dynamics using the inertia tensor[2]
- have skills in analyzing symmetries and the corresponding integrals of motion, choosing appropriate mathematical models and solution methods, transforming to canonical variables, performing graphical analysis of orbits and potential curves; generalizing and adapting methods of theoretical mechanics to complex physical systems; evaluating the applicability of various approaches to real-world problems[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Mathematical Analysis, Linear Algebra and Analytic Geometry, Mechanics, Differential Equations

Bibliography


1. Fayzullayev B. Nazariy mexanika. Toshkent, 2011 y.
2. Karimxo‘jayev A., Latipov A.Sh. Nazariy mexanika masalalarda. O‘quv qo‘llanmasi. T., Universitet, 1992 y.
3. Landau L.D., Lifshis Y.M. Nazariy fizika qisqa kursi. Tom1, T. O‘qituvchi, 1971


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 32-33 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** carried out after completion of sections related to lectures and problem-solving, covering half of the total material. The studied material is divided into variants, each containing 3 theoretical questions and 1 problem. Answers are accepted in written form. A student can receive a maximum of 5 points for each correct answer.
**Final Assessment:** carried out based on compiled variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. After submitting the written answers, the student then answers the questions orally and can receive a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| ATFB306 | Atomic Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 5 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Prof., Dr. Polvonov Sotimboy; Associate Prof., Dr. Mamayusupova Mukaddas

**Course content**

The science of atomic physics. History and stages of development of atomic physics. Thermal radiation. Corpuscular properties of electromagnetic radiation. Bohr's theory of the hydrogen atom. Isotopic shifts of atomic levels. Particles and waves. The uncertainty relation. Fundamentals of quantum mechanics. Particle tunneling through a potential barrier. One-electron atoms. Electron spin. Multi-electron atoms. Isotopic effects in atoms. Justification of the shell model. Mechanical and magnetic moments of atoms. Selection rules for electric dipole transitions at LS coupling. Characteristic X-ray radiation. Spontaneous emission of multiple electrons by atoms. Atoms in external fields. Molecules.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the fundamental concepts and principles of atomic physics: stages of development of atomic models, Bohr's postulates, radiation laws, structure of one- and many-electron atoms, quantum numbers, Pauli and Hund's principles, spin, magnetic and mechanical moments, isotopic shifts, selection rules, and laws governing the interaction of atoms with external fields (Zeeman and Stark effects)[1]
- be able to apply Bohr's model and quantum mechanics to calculate energy levels and spectral transitions, interpret atomic spectra, analyze the behavior of atoms in electric and magnetic fields, compute electronic configurations, and use selection rules to predict spectral lines[2]
- have skills in correlating experimental data with spectroscopic models, analyzing quantum effects (spin, orbital moments, tunneling), interpreting level splitting, critically evaluating quantum-mechanical models and their applicability; formulating substantiated conclusions about the structure and properties of atoms by integrating knowledge from different areas of physics[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Mechanics, Thermal Physics, Mathematical Analysis, Electricity and Magnetism, Optics

**Bibliography**


1. Axmedova G., Mamatqulov O.B., Xolbaev I. Atom fizikasi. O'quv qo'llanma. T.: Istiqlol, 2013. - 416 b.
2. Сивухин Д. В. Общий курс физики. Учеб. пособие: Для вузов. В 5 т. Т. V. Атомная и ядерная физика. М.: ФИЗМАТЛИТ;Изд-во МФТИ, 2002.- 784 с.
3. Колмаков Ю.Н., Пекар Ю.А., Лежнева Л.С., Семин В.А., Основы квантовой теории и

атомной физики, Учеб. Пособие, Тула, 2003.-144
4. Polvonov S.R., Kanokov Z., Ruzimov Sh.M. Atom va yadro fizikasidan masalalar to'plami. O'quv qo'llanma. T.: Universitet, 2017. - 199

Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 9-10 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** carried out after completion of sections related to lectures and problem-solving, covering half of the total material. The studied material is divided into variants, each containing 3 theoretical questions and 1 problem. Answers are accepted in written form. A student can receive a maximum of 5 points for each correct answer.
**Final Assessment:** carried out based on compiled variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. After submitting the written answers, the student then answers the questions orally and can receive a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| EDNB306 | Electrodynamics | | |
|---|---|---|---|
| | | | |
| Academic semester | 5 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Лектор**

Prof. Dr. Musakhanov Mirzayusuf; Prof., Dr. Akramov Tokhir

**Course content**

Special theory of relativity. Lorentz transformations. Elements of relativistic mechanics. Electromagnetic charge in a field. Lorentz transformations for electromagnetic quantities. Fundamental equations of electrodynamics. Law of conservation of electromagnetic energy. Electrostatics. Stationary magnetic field. Electromagnetic field in vacuum. Field of a system of charges in arbitrary motion. Dipole radiation.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the fundamental principles of electrodynamics: Maxwell–Lorentz equations, principles of the special theory of relativity, Lorentz transformations, relativistic mechanics, structure of the electromagnetic field, the nature of displacement currents, fundamentals of radiation theory, and retarded potentials[1]
- be able to apply tensor and vector formalisms to describe electromagnetic phenomena, use Lorentz transformations to analyze fields in different reference frames, solve problems on the motion of a charge in an electromagnetic field considering relativistic effects, perform calculations of fields and potentials, and analyze the propagation and radiation of electromagnetic waves[2]
- have skills in interpreting the behavior of electromagnetic fields in vacuum and matter, analyzing radiation, propagation, and interaction with matter, modeling processes based on Maxwell's equations, critically evaluating electrodynamic models, and formulating conclusions about the regularities underlying observable physical phenomena[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No

Recommended: Linear Algebra and Analytic Geometry, Electricity and Magnetism, Differential Equations, Theoretical Mechanics

**Bibliography**


1. Abdumalikov A.A., Elektrodinamika, Darslik "Cho'lpon" , T., 2011.
2. Ландау Л.Д., Лифщиц Е.М., Теория поля, М.,1989.


**Assessments**

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 11-12 th week | 19-20 th week |

| Form of Assessment | written exam | written and oral exam |
|---|---|---|

**Continuous Assessment:** conducted after mastering the sections related to lectures and problem-solving, covering approximately half of the total course. The studied material will be distributed into variants, each containing 3 theoretical questions. Answers are submitted in written form. A student can receive a maximum of 5 points for each correct answer.

**Final Assessment:** conducted on the basis of variants covering all studied topics. Each student is given a variant containing 3 theoretical questions from the semester's material. Answers are submitted in written form. After submitting the written work, the student answers the questions orally and can earn a maximum of 5 points for each answer. The final grade is determined as the arithmetic mean.

| Educational Materials and Media Tools |
|---|
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| RADB306 | Fundamentals of Electronics | | |
|---|---|---|---|
| | | | |
| Academic semester | 5 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom and laboratory sessions | 60 h |
| Laboratory work | 60 h | Literary Studies | 30 h |
| Total | 90 h | Total | 90 h |
| Total work-load | 180 h | | |

**Lecturers**

Associate Prof. Dr. Akhmadjanov Turgunali; Associate Prof., Dr. Talipov Damir

**Course content**

**General part.** Introduction to the course *Fundamentals of Electronics*. Electric circuits. Circuit parameters. Differentiating and integrating circuits. Resonant circuits. Coupled oscillatory circuits. Semiconductor electronics. Semiconductor diode. Transistors. Field-effect transistors. MOSFET transistors. Amplifiers. Feedback in amplifiers. Oscillators. Amplitude–phase balance. Electronic stabilizers. Signals. Basics of digital electronics.

**Laboratory work.** Study of diode operation. Investigation of bipolar transistor operation. Investigation of field-effect transistor operation. AC rectifier. Rectifiers. Amplifier tuned to resistors (RC amplifier). Feedback in amplifiers. Emitter follower. Electronic stabilizer. Resonant amplifier. Operational amplifier. RC oscillator. LC oscillator. Multivibrator. Study of logic circuits.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the basic concepts of radioelectronics and the physics of electronic devices: electric circuits, resonant circuits, analog and digital circuits, operating principles of semiconductor devices (diodes, bipolar and field-effect transistors, MOS structures), the design of amplifiers, oscillators, rectifiers, stabilizers, and logic elements; as well as the fundamentals of constructing laboratory setups for circuit and device investigation[1]
- be able to assemble, calculate, and analyze circuits based on semiconductor elements; measure electrical parameters using multimeters, oscilloscopes, and other laboratory instruments; design and implement amplifiers, oscillators, rectifiers, and digital units; use simulation software (LTspice, Multisim, etc.) for circuit modeling; analyze transient processes, resonance, and the effects of capacitance and inductance[2]
- have skills in analyzing the time and amplitude characteristics of signals, evaluating transistor operating modes and circuit stability, selecting the topology of electronic devices depending on the task; explaining the behavior of radioelectronic systems from the perspective of physics and engineering; independently formulating hypotheses, conducting experiments, interpreting results, comparing them with calculations, and justifying technical solutions[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Lab Work; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Electricity and Magnetism, Physics Laboratory

**Bibliography**

1. Хоровиц П., Хилл У. Искусство схемотехники: Пер. с англ.-Изд.2-е. - М.: Издательство БИНОМ. - 2014. - 704 с.
2. V K. Mehta, R.Mehta. Principles of Electronics. 11th Edition Tata Mgraw Hill. 2006.
3. Новожилов О.П. Электроника и схемотехника. - М.: Издательство Юрайт. - 2018. - 382 с.
4. Нигматов Х. Радиоэлектроника асослари. Тошкент, “Ўзбекистон” 1994
5. G’.B.Eshonqulov, D.O.Tolipov, T.Akhmadjanov “Radioelektronoka asoslari fanidan laboratoriya ishlari”. Uslubiy qo’llanma. “Universitet”-Toshkent, 2013.-124 b.

## Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 13-14 th week | 19-20 th week |
| Form of Assessment | Written exam или тест | written and oral exam |

**Continuous Assessment:** conducted after mastering sections related to lectures and laboratory work. a) Based on variants consisting of 2 questions derived from the course topics: each question is graded up to 5 points, and the CA-1 result is determined as the average of the two scores, rounded up. b) In the form of a test: variants with 20 questions each are prepared and graded as follows: (18–20) = 5; (14–17) = 4; (11–13) = 3; (0–10) = 2.

**Final Assessment:** conducted in the form of a written exam based on the course topics, laboratory assignments, and independently studied material. Each variant consists of 3 theoretical questions and 1 laboratory-related question, each graded up to 5 points. The final grade is determined as the arithmetic mean of the scores. b) In the form of a test: variants with 20 questions each are prepared and graded as follows: (18–20) = 5; (14–17) = 4; (11–13) = 3; (0–10) = 2.

## Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials; laboratory setups; measuring instruments and devices.

| YADB306 | Nuclear and Elementary Particles Physics | | |
|---|---|---|---|
| Academic semester | 6 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Prof. Polvonov Sotimboy; Associate Prof. Mamayusupova Mukaddas

**Course content**

Introduction to the course "Nuclear and Elementary Particles Physics." Main properties of atomic nuclei. Nuclear forces. Nuclear models. Radioactivity. Nuclear gamma radiation. Interaction of nuclear radiation with matter. Interaction of gamma radiation with matter. Interaction of neutrons with matter. Biological effects of radiation and radiation protection. Nuclear reactions. Types of nuclear reactions. Nuclear energy. Elementary particles. Feynman diagrams. Quarks. Composite particles and hadrons. Discovery of J/ψ. Charmonium. The Universe. Nucleosynthesis in stars. Neutron stars. Black holes.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the main characteristics of atomic nuclei (charge, mass, binding energy, isospin); the nature and models of nuclear forces (liquid drop, shell, etc.); the laws of radioactive decay and the classification of radioactivity (α, β, γ); the principles of interaction of radiation (γ-quanta, neutrons, charged particles) with matter; the basics of radiation protection; the classification of nuclear reactions; the fundamental elementary particles and their properties (spin, charge, mass, types of interactions); the structure of quarks, leptons, hadrons; the fundamental interactions; key discoveries in particle physics (e.g., J/ψ, charmonium); the basics of nucleosynthesis; the properties of neutron stars and black holes[1]
- understand the relationship between experiment and theoretical models in nuclear and subnuclear physics; the mechanisms of interaction of radiation with matter and the principles of detection; the concepts of reaction threshold, cross-section, particle lifetime; the principles of symmetries and conservation laws (energy, charge, baryon and lepton numbers); as well as the limitations of applied models, including the use of Feynman diagrams[1]
- be able to calculate parameters of nuclear systems: binding energy, reaction kinematics, half-lives; determine interactions of radiation with matter and select appropriate protective measures; apply programming languages and numerical methods (including Monte Carlo) to model decay, reactions, and particle propagation; visualize spectra, particle distributions, and their properties[2]
- have skills in analyzing experimental and computational data on nuclear and subnuclear processes; interpreting them from the standpoint of modern physics; evaluating model stability under parameter variations; comparing modeling results with observed data; generalizing modeling outcomes and drawing conclusions on the validity and applicability of models; assessing the role of nuclear and particle physics in technology, energy, medicine, and astrophysics[3]

[1] knowledge; [2] skills; [3] abilities;

| Teaching and learning methods |
|---|
| Lectures; Problem solving; Self-study; Group work; |
| **Admission requirements** |
| Mandatory: No<br>Recommended: Mechanics, Thermal Physics, Mathematical Analysis, Electricity and Magnetism, Optics, Atomic Physics |
| **Bibliography** |
| 1. Мухин К.Н. Экспериментальная ядерная физика: Учебник. В 3-х тт. Т. 1. Физика атомного ядра. 7-е изд., стер. - СПб.: Изд-во «Лань», 2009. - 384 с.<br>2. Krane K.S. Introductory nuclear physics. Oregon State University, John Wiley and Sons, New York, 1988, 872 pages.<br>3. Polvonov S.R., Bozorov E., Kanokov Z. Ruzimov Sh.M. Atom yadrosi va elementar zarralar fizikasi. O'quv qo'llanma. T.: Fan va texnologiya, 2019. - 168 b.<br>4. Polvonov S.R., Kanokov Z., Ruzimov Sh.M. Atom va yadro fizikasidan masalalar to'plami. O'quv qo'llanma. T.: Universitet, 2017. - 199 b. |
| **Assessments** |
| Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.<br><br>**Type of Assessment** — **CA**: Timing: 29-30 th week; Form of Assessment: written exam — **FA**: Timing: 37-38 th week; Form of Assessment: written and oral exam<br><br>**Continuous Assessment:** carried out after completion of sections related to lectures and problem-solving, covering half of the total material. The studied material is divided into variants, each containing 3 theoretical questions and 1 problem. Answers are accepted in written form. A student can receive a maximum of 5 points for each correct answer.<br>**Final Assessment:** carried out based on compiled variants covering all studied topics. Each student receives a variant with 3 theoretical questions and 1 problem on topics studied during the semester. Answers are accepted in written form. After submitting the written answers, the student then answers the questions orally and can receive a maximum of 5 points for each answer. The final grade is calculated as the arithmetic mean. |
| **Educational Materials and Media Tools** |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| KVMB306 | Quantum Mechanics | | |
|---|---|---|---|
| | | | |
| Academic semester | 6 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 44 ч | Preparation for classes | 30 h |
| Problem solving | 46 ч | Literary Studies | 60 h |
| Total | 90 h | Total | 90 h |
| Total work-load | 180 h | | |

**Лектор**

Prof. Dr. Musakhanov Mirzayusuf; Prof., Dr. Akramov Tokhir

**Course content**

Fundamentals of quantum theory. Foundations of quantum mechanics. Representation of mechanical quantities by operators. Time-dependent changes in conditions. One-dimensional problems. Motion of a particle in a central force field. Spin. Intrinsic mechanical and magnetic moments of the electron. Systems of identical particles. Indistinguishability of particles. Perturbation theory. Scattering theory. Anharmonic oscillator. Multi-electron atoms. Elements of relativistic quantum mechanics.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the main postulates of quantum mechanics, its differences from classical physics and its domain of applicability; the principles of motion in a central force field; the structure of the hydrogen atom; the properties of spin and identical particles; the mathematical formalism of quantum theory (operators, eigenvalues and eigenfunctions, the superposition principle); the basics of perturbation and scattering theories, including the Born approximation and the description of elastic scattering[1]
- understand the physical nature of quantum phenomena: wave–particle duality, tunneling, energy quantization; the significance of the uncertainty principle and its impact on measurements and the evolution of microsystems; the behavior of particles in potential wells, barriers, bound states, and in scattering processes[1]
- be able to solve problems related to determining energy spectra and wave functions for simple quantum systems (one-dimensional potential well, harmonic oscillator, hydrogen atom); apply operator formalism and symmetries in calculations; use perturbation theory and approximate methods for systems without exact solutions; interpret the wave function and the physical meaning of the Schrödinger equation[2]
- have skills in analyzing quantum states, transition probabilities, constructing diagrams and symbolic representations; critically assessing microscopic models and comparing them with experimental data; making theoretical generalizations and formulating physical conclusions based on mathematical formalism[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No

Recommended: Mathematical Analysis, Linear Algebra and Analytic Geometry, Differential Equations, Theoretical Mechanics

**Bibliography**

1. Musaxonov M. M., Rahmatov A.S. “Nazariy fizika kursi”, T.3, Kvant mexanikasi, Toshkent,

Tafakkur bo‘stoni, 2011
2. Akramov T.V., Kvant mexanikasining matematik apparati, T. “Ma’rifat”, 2023
3. Блохинцев Д.И., Основы квантовой механики, Выс. школа М., 1983

Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 32-33 th week | 37-38 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** carried out after completing the sections related to lectures and problem solving, covering about half of the total course content. The completed material will be distributed among variants, each containing 3 theoretical questions. Answers must be submitted in written form. A maximum of 5 points is awarded for each correct answer.

**Final Assessment:** conducted based on variants compiled from all studied topics. Each student receives a variant with 3 theoretical questions covering the topics of the semester. Answers are provided in written form. After submitting the written answers, the student will respond orally to additional questions and may earn up to 5 points for each answer. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| FOMB4061 | Methods of Teaching Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 5 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 30 h |
| Seminars | 30 h | Literary Studies | 60 h |
| | | Preparation of a coursework project | 30 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

**Lecturers**

Associate Prof. Dr. Begmatova Dilfuza; Prof., Dr. Kurvanov Mirzaakhmat

**Course content**

Factors influencing the development of the education system. Decisions and regulations concerning education: the National Curriculum for General Secondary Education, general competencies developed in students within the natural sciences block-module. The teaching profession and its role in contemporary society. Methods of teaching physics. The aim and tasks of this discipline. The emergence and development of methodologies for teaching physics and mathematics. The tasks of physics teaching methodology in improving instruction at general secondary, vocational, and higher education levels. Main issues of physics teaching methodology: scientific, educational, and worldview aspects. Methods of teaching physics and mathematics in the general secondary education system. Methods of solving physics problems. Classification of physics problems. Methodology of solving physics problems in different ways. Methods and techniques for conducting educational physics experiments. Methods and techniques for preparing and demonstrating demonstration experiments. Application of innovative technologies in education. Activating student engagement in the process of learning physics. Methods of applying problem-based educational technologies in physics teaching. Classification of teaching methods in physics. Features of teaching styles in specialized secondary, vocational colleges, and higher education institutions. The lesson as the main form of instruction. Types and structures of lessons. Methods of teaching physics at different stages of general secondary education. Methodology of monitoring and assessing students' cognitive and educational activities. Methods of fostering students' interest in physics and mathematics and stimulating their learning activities.

**Learning objectives**

Upon successful completion of this course, students should be able to:

- know the regulatory documents and strategic decisions in education (state educational standards, national curricula, block-module structure); the goals, tasks, and content of physics teaching methodology as a discipline; its stages of development and interrelation with mathematics teaching methodology; classification of physics problems, types of lessons and their didactic structure; methods of preparing and demonstrating experiments; modern educational technologies and techniques for enhancing student engagement[1]
- understand the significance of physics teaching methodology for shaping students' scientific worldview; the role of the physics teacher in the modern school and society; the structure of the educational process at different levels of education; the didactic potential of problem-based, activity-based, and project-based approaches; the importance of assessment and evaluation as tools for developing learning motivation[1]
- be able to design and conduct lessons of various types (lectures, laboratory work, practicums, seminars) using diverse teaching methods; solve and analyze problems of varying levels of complexity with the application of mathematical methods and different unit systems; conduct, describe, and interpret physics experiments; use digital

technologies, electronic resources, programming languages, and modeling in educational practice; adapt teaching methods to students' preparedness levels[2]

- have skills in analyzing and assessing the effectiveness of methods, lesson structure and content, student behavior and motivation; identifying pedagogical problems and developing solutions for specific educational situations; creating and adapting teaching materials; developing personal pedagogical approaches; interpreting the results of pedagogical experiments; generalizing and presenting professional experience in the form of recommendations, publications, and presentations[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Lectures; Seminars; Self-study; Group work;

Admission requirements

Mandatory: No.
Recommended: General Pedagogy. Psychology

Bibliography

1. Begmatova D.A., Qurbonov M., Sodiqova Sh., Abdullayev N.Q., Suvonova O.D. Fizika o'qitish metodikasi darslik. Toshkent, 2023
2. Qurbonov M., Uzoqova G.S., Tursunov K.Sh. "Fizika o'qitishning nazariy asoslari" T."O'zbekiston" 2008.
3. Jo'rayev M.D. "Fizika o'qitish metodikasi (umumiy masalalar)" T., TDPU., 2015.

Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completing the sections related to lectures and problem solving, covering about half of the course material. The studied content will be distributed into variants, each containing 3 theoretical questions. Answers must be submitted in written form. A maximum of 5 points is awarded for each correct answer.

**Final Assessment:** conducted on the basis of variants compiled from all studied topics. Each student receives a variant containing 3 theoretical questions covering the semester topics. Answers are provided in written form. After submitting the written answers, the student will orally respond to additional questions and may earn up to 5 points for each answer. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| MMFB406 | Methods of Mathematical Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classes | 60 h |
| Problem solving | 30 h | Literary Studies | 60 h |
| Total | 60 h | Total | 120 h |
| Total work-load | 180 h | | |

Лектор

Associate Prof., Dr. Fayzullayev Beruni; Associate Prof., Dr. Karimkhodjayev Abdugapur

Course content

Special Functions. Bessel functions. Integral representation of the Bessel function. Legendre polynomials. Generalized Legendre polynomials. Classification of second-order partial differential equations: the case of two independent variables. General theory. The hyperbolic case. The parabolic equation. The elliptic equation. Their canonical forms. Physical processes leading to hyperbolic equations. Processes leading to parabolic equations. The method of traveling waves. Infinitesimally narrow case: the problem of free oscillations. D'Alembert's formula. The problem of eigenfunctions and eigenvalues. The method of separation of variables – Fourier method. Hyperbolic equations. Application of the Fourier method to parabolic equations. Boundary value problems for elliptic equations. The Green's function method. The concept, properties, and representations of the δ-function.

Learning objectives

Upon successful completion of this course, students should be able to:

- know the main special functions used in problems of mathematical physics (Bessel functions, Legendre polynomials, and generalized Legendre polynomials); the classification of second-order partial differential equations and their canonical forms; analytical methods of solution (separation of variables, Fourier transform, Green's function); physical processes described by hyperbolic, parabolic, and elliptic equations; properties of the δ-function and its applications in problem solving[1]
- understand the physical nature of processes modeled by differential equations; the mathematical structure of problems and their relation to real physical phenomena; the role of analytical and numerical modeling in scientific research; the limitations of methods used in describing real processes[1]
- be able to apply analytical methods – separation of variables, integral representations, Fourier series expansions – in solving problems of mathematical physics; use numerical methods and software tools (MATLAB, Python, Mathematica) to approximate solutions when an analytical approach is not feasible; model diffusion, oscillatory, and stationary processes; perform calculations and visualization of solutions; analyze sensitivity of solutions to initial and boundary conditions[2]
- have skills in constructing and adapting computational schemes for specific physical problems; assessing the accuracy, stability, and reliability of numerical solutions; comparing modeling results with experimental data and theoretical expectations; selecting the optimal solution method depending on problem conditions; interpreting spectral properties and the behavior of eigenfunctions in boundary value problems[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Lectures; Problem solving; Self-study; Group work;

| Admission requirements |
|---|
| Mandatory: No<br>Recommended: Linear Algebra and Analytic Geometry, Electricity and Magnetism, Differential Equations |
| **Bibliography** |
| 1. Fayzullaev B.F., Rahmatov A.S. Matematik fizika metodlari. Toshkent, Universitet, 2014.<br>2. Тихонов А.Н., Самарский А.А. Уравнения математической физики. М., Наука, 1973.<br>3. Budak B.M., Тихонов А.Н., Самарский А.А. Сборник задач по уравнениям математической физики. М., Наука, 1971.<br>4. Тешабоева Н.Х. Математик физика методлари. Т., “Ўқитувчи”, 1980. |
| **Assessments** |
| Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.<br><br>**Type of Assessment** — **CA**: Timing: 11-12 th week; Form of Assessment: written exam — **FA**: Timing: 19-20 th week; Form of Assessment: written and oral exam<br><br>**Continuous Assessment:** conducted after covering the sections related to lectures and problem solving, amounting to half of the total course. The material will be distributed into variants, each containing 2 theoretical questions and 1 problem. Written answers are required. A student can earn up to 5 points for each correct answer.<br>**Final Assessment:** based on variants covering all topics studied in the course. Each student receives a variant with 3 theoretical questions and 2 problems studied during the semester. Written answers are required. After submitting the written answers, the student answers additional questions orally and can score up to 5 points per question. The final grade is calculated as the arithmetic mean. |
| **Educational Materials and Media Tools** |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| TSFB406 | Statistical Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 6 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 44 ч | Preparation for classes | 30 h |
| Problem solving | 46 ч | Literary Studies | 60 h |
| Total | 90 h | Total | 90 h |
| Total work-load | 180 h | | |

Лектор

Associate Prof., Dr. Fayzullayev Biruni; Prof., Dr. Akramov Tokhir

Course content

The statistical method. Phase space. Liouville's theorem. Microcanonical distribution. Statistical matrix. Entropy and the law of its increase. Magnetic systems. Temperature. Pressure. Work and heat. Clausius inequality. Maximum work. Adiabatic process. Thermodynamic potentials. Positive definiteness. Joule–Thomson process. The four laws of thermodynamics. Gibbs distribution. Maxwell distribution. Free energy. Grand canonical distribution. Ideal gas. Boltzmann distribution. Number of collisions. Equation of free energy and equation of state of the ideal gas. Gas with constant heat capacity. The equipartition theorem. Monatomic ideal gas. Diatomic molecular gas. Fermi–Dirac and Bose–Einstein distributions. Gases consisting of fermions and bosons. Degenerate electron gas. Bose-condensed gas. Blackbody radiation. Thermodynamics of solids. van der Waals equation. Phase transitions. Clausius–Clapeyron equation. Kinetic equation. Boltzmann's H-theorem.

Learning objectives

Upon successful completion of this course, students should be able to:

- know the fundamentals of the statistical method and its distinctions from Thermal Physics; phase space, Liouville's theorem, microcanonical, canonical, and grand canonical ensembles; Maxwell, Boltzmann, Fermi–Dirac, and Bose–Einstein distributions; thermodynamic potentials; equations of state (including van der Waals and Clausius–Clapeyron equations); entropy, Boltzmann's H-theorem, and the model of an ideal gas; relations between microscopic parameters and macroscopic quantities; differences between statistical ensembles and their applicability; the physical meaning of distributions and thermodynamic quantities in probabilistic models; the role of statistical methods in describing first- and second-order phase transitions[1]
- be able to apply Gibbs, Boltzmann, Fermi–Dirac, and Bose–Einstein distributions to calculate properties of classical and quantum systems; derive and use the Boltzmann kinetic equation; describe phase transitions and the behavior of systems near critical points; analyze particle distributions in Fermi and Bose gases, including electron and photon gases; calculate heat, work, energy, entropy, and heat capacity in various thermodynamic processes; evaluate the applicability of different models of matter to specific problems; identify sources of error and assess the stability of numerical results[2]
- possess skills in selecting appropriate statistical models for analyzing physical problems; performing numerical and analytical analysis of thermodynamic systems; developing and adapting models for studying new states of matter (e.g., Bose–Einstein condensates); comparing theoretical predictions with experimental data and justifying the validity of conclusions; critically evaluating modeling results with regard to the assumptions and approximations used[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Lectures; Problem solving; Self-study; Group work;

Admission requirements

Mandatory: No
Recommended: Linear Algebra and Analytic Geometry, Electricity and Magnetism, Differential Equations

Bibliography


1. Fayzullayev B.A. Termodinamika va statistik fizika, Toshkent 2023
2. Abdumalikov A.A. Mamatqulov R. Termodinamika va statistik fizika, Toshkent, “Cho‘lpon”, 2008
3. Ландау Л.Д., Лифшиц Е.М. Курс теоретической физики, том 5, Статистическая физика. М., Наука, 2010
4. Кубо Р. Статистическая механика, М. 1967


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 11-12 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after covering the sections related to lectures and problem solving, amounting to half of the total course. The material will be distributed into variants, each containing 2 theoretical questions and 1 problem. Written answers are required. A student can earn up to 5 points for each correct answer.

**Final Assessment:** based on variants covering all topics studied in the course. Each student receives a variant with 3 theoretical questions and 2 problems studied during the semester. Written answers are required. After submitting the written answers, the student answers additional questions orally and can score up to 5 points per question. The final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| UK2304 | General Chemistry | | |
|---|---|---|---|
| | | | |
| Academic semester | 3 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom and laboratory sessions | 30 h |
| Laboratory work | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Abdullayev Jakhongir

**Course content**

Fundamental concepts of chemistry. Basic laws of chemistry. Atomic structure. Periodic system of chemical elements and Mendeleev's periodic law. Major classes of inorganic compounds. Oxides, acids, bases, and salts. Chemical bonding and its types. Chemical kinetics and chemical equilibrium. General properties of solutions. Electrolytic dissociation. Hydrolysis of salts. Redox reactions. Electrolysis. Faraday's laws of electrolysis. Galvanic cells. Metal corrosion. Metals and nonmetals. Complex compounds. Fundamental concepts of organic chemistry. Chemical properties of hydrocarbons. Properties of hydrocarbons containing halogens, oxygen, and nitrogen.

**Learning objectives**

Upon successful completion of this course, students should:

- know the fundamental concepts and laws of chemistry, including the laws of conservation of mass, definite and multiple proportions, etc.; the periodic law and the periodic system of chemical elements; the major classes of inorganic compounds (oxides, acids, bases, salts) and their properties; types of chemical bonds (ionic, covalent, metallic, hydrogen) and their characteristics; the fundamentals of chemical kinetics, chemical equilibrium, electrolytic dissociation, and salt hydrolysis; the principles of redox reactions, the laws of electrolysis, the basics of galvanic cells, corrosion, and complex compounds; the key concepts of organic chemistry and the properties of hydrocarbons and their derivatives[1]
- be able to apply chemical laws and formulas to solve quantitative and qualitative problems; perform calculations in different unit systems and use mathematical methods for processing results; describe chemical phenomena, processes, and experiments on the basis of studied principles and models; plan and carry out basic laboratory work (preparing reagents, selecting glassware, performing measurements and experiments); calculate experimental data, determine errors, and draw substantiated conclusions; interpret chemical reactions within theoretical frameworks[2]
- possess skills in the synthesis and identification of simple inorganic compounds; determining physicochemical parameters of substances and classifying them by chemical properties; using nomenclature of organic compounds (historical, rational, systematic); selecting and using laboratory equipment and glassware appropriately; applying acquired knowledge in interdisciplinary contexts, including physicochemical analysis of substances and processes[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Laboratory work; Self-study; Group work;

**Admission requirements**

Mandatory: No

Recommended: Basic high school knowledge of chemistry, physics, and mathematics.

## Bibliography


1. Eshmamatova N.B., Mirxamitova D.X., Azimova G.Z. «Umumiy kimyo». Toshkent, 2022. "Lesson press". -362 b
2. Глинка Н.Л. Общая химия. Москва: “Интеграл-Пресс”, 2018. -728
3. Theodore L. Brown. Chemistry. The central science13th Edition USA.2014
4. Inorganic Chemistry. T. L. Overton, J. P. Rourke, M. T. Weller, and F. A. Armstrong 2018. 7 th edition. Oxford University Press. -967 p.
5. Yangibayev A., Turgunov E. Fiziklar uchun kimyo. O‘quv qo‘llanma. Toshkent 2020. “Go To Print” 303 b.


## Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 11 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Grading Criteria**

**a) To obtain a grade of “5” (Excellent), a student must:**

- Fully reveal the essence and content of the discipline.
- Maintain a scientific and logical approach in explanations, avoiding errors or inconsistencies.
- Clearly understand the theoretical and practical significance of the topics studied.
- Demonstrate independence and free thinking within the discipline.
- Provide precise and concise answers to questions.
- Have a thoroughly prepared notebook.
- Fully and accurately complete all independent assignments.
- Publish a scientific article on one of the course topics.

**b) To obtain a grade of “4” (Good), a student must:**

- Understand the essence and content of the discipline, presenting topics without scientific or logical inconsistencies.
- Recognize the practical significance of the discipline.
- Complete tasks and exercises within the curriculum.
- Provide correct answers to questions.
- Keep a well-structured notebook.
- Complete independent assignments.

**c) To obtain a grade of “3” (Satisfactory), a student must:**

- Have a general idea of the subject.
- Present topics in a limited manner with some confusion.
- Show insufficiently coherent speech when presenting material.
- Provide incomplete and unclear answers to questions.
- Keep a poorly structured notebook.

**d) A grade of “2” (Unsatisfactory) may be assigned if:**

- The student is unprepared for classes.
- The student has no understanding of the subject matter.
- The student’s work contains obvious borrowing from peers.
- The text contains serious mistakes and confusion.
- The student cannot answer questions on the subject.
- The student lacks knowledge of the discipline.

## Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| KA2304 | Fundamentals of Chemistry | | |
|---|---|---|---|
| | | | |
| Academic semester | 3 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom and laboratory sessions | 30 h |
| Laboratory work | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Abdullayev Jakhongir

**Course content**

The relationship of chemistry with the physical sciences, fundamental concepts and laws of chemistry. The atom and its structure. Types of chemical bonding. The most important classes of inorganic compounds. Chemical kinetics and chemical equilibrium. General information about solutions. Electrolyte solutions. Hydrolysis of salts. Acid–base equilibrium. Buffer systems. Complex compounds. Redox reactions. Organic compounds and their classification. Aliphatic hydrocarbons. Aromatic hydrocarbons. Alcohols and phenols. Compounds containing a carbonyl group. Compounds containing a carboxyl group. Lipids.

**Learning objectives**

Upon successful completion of this course, students should:

- have knowledge of chemical laws and formulas, methods of solving and analyzing problems, mathematical methods of calculation in various unit systems; principles, idealized models, and schemes applied in chemistry, as well as their limits of applicability; be able to describe chemical experiments, demonstrations, and phenomena on the basis of chemical laws and principles; prepare, conduct, and measure simple laboratory experiments; calculate experimental data, account for errors, and draw conclusions regarding the quality of the experiment[1]
- possess skills in the synthesis of chemical compounds, in their identification, and in the determination of their physicochemical constants[2]
- be able to name organic compounds according to historical, rational, and systematic nomenclature; select appropriate laboratory glassware for experiments; apply organic synthesis methods in practice[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Laboratory work; Self-study; Group work;

**Admission requirements**

Mandatory: No

Recommended: Basic high school knowledge of chemistry, physics, and mathematics

**Bibliography**


1. Эшматова Н.Б., Мирхамитова Д.А., Азимова Г.А.. «Умумий кимё». Тошкент, 2022. "Lesson press". -362 б.
2. Ahmerov Q.., Jalilov A.., Sayfuttinov R.., Akbarov A.., Turobjonov S.. Umumiy va anorganik kimyo/ Toshkent. 2017.
3. Mamadiyorova X.S.., Lutfullayev E.L.. Kimyo//darslik. Samarqand. 2014. 670 b.
4. Аҳмеров Қ., Жалилов А., Исмоилов А. Умумий ва анорганик кимё. Тошкент. 2003.
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Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 11 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Grading Criteria**

**a) To obtain a grade of "5" (Excellent), a student must:**

- Fully demonstrate understanding of the essence and content of the discipline.
- Maintain a scientific and logical approach in explanations, avoiding scientific errors and inconsistencies.
- Clearly understand the theoretical or practical significance of the studied topics.
- Show independence and free thinking within the discipline.
- Provide accurate and concise answers to assigned questions.
- Keep a thoroughly prepared notebook.
- Complete all independent assignments fully and accurately.
- Publish a scientific article on one of the course topics.

**b) To obtain a grade of "4" (Good), a student must:**

- Understand the essence and content of the discipline, presenting topics without scientific or logical errors.
- Recognize the practical significance of the discipline.
- Complete exercises and tasks within the curriculum.
- Provide correct answers to questions on the subject.
- Keep a well-prepared notebook.
- Complete independent assignments.

**c) To obtain a grade of "3" (Satisfactory), a student must:**

- Have a general idea of the subject.
- Present topics in a limited way, with some confusion.
- Display insufficiently coherent speech when explaining.
- Provide incomplete or unclear answers to questions.
- Keep a poorly structured notebook.

**d) A grade of "2" (Unsatisfactory) may be assigned if:**

- The student is unprepared for classes.
- The student has no understanding of the course content.
- The student's work contains obvious borrowing from peers.
- The text contains serious mistakes and confusion.
- The student cannot answer questions on the subject.
- The student lacks basic knowledge of the discipline.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| AA2404 | Astronomy and Astrophysics | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom activities (lecture review, solving exercises) | 30 h |
| Problem solving | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

Lecturers

Prof., Dr. Akhunov Talat

Course content

Elements of spherical astronomy. Apparent and true motions of celestial bodies. Fundamentals of spherical trigonometry. Precession and nutation. The parallactic triangle. Refraction. Parallax. Apparent and true planetary motions and their configurations. Orbital elements of planets. Eclipses. Fundamentals of observational astrophysics, the electromagnetic spectrum. Photometry. Radiation laws. Methods for determining stellar temperatures. Purpose and main characteristics of telescopes. Radiation detectors. Main physical parameters of the Sun, its spectrum and chemical composition. The solar atmosphere, chromosphere, and corona. Internal structure of the Sun, its magnetic field and activity. Atmospheres and internal structures of terrestrial planets. Atmospheres, interiors, satellites, and rings of giant planets. Asteroids and comets. Origin of the Solar System. Birth and evolution of stars: stationary (normal) stars, their spectral classes. Relationships among main stellar physical parameters. Stellar interiors. Binary stars. Variable stars. Pulsating stars. Relativistic compact objects. Eruptive stars. Pulsars (neutron stars). Interstellar gas and dust, physics and structure of the Milky Way. Star clusters and associations. Molecular clouds of our Galaxy. Interstellar extinction. Physical state and variations of the interstellar medium. Structure of the Galaxy. Galactic halo and magnetic field. Physics of galaxies: galaxy types and structures. Classification of galaxies. Redshift in galactic spectra and Hubble's law. Distance determination to galaxies. Spatial distribution of galaxies, their composition and properties. Active galaxies: radio galaxies, quasars, gravitational lenses. Cosmological models: current issues in cosmology. The cosmological principle. Critical density. Cosmic microwave background. Composition of the Universe. Dark matter. Dark energy and the accelerated expansion of the Universe.

Learning objectives

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the basics of spherical astronomy: celestial sphere, coordinate systems, precession, nutation, parallax, refraction, and the parallactic triangle; the nature and laws of apparent and true motions of celestial bodies, planetary motions and configurations, conditions for eclipses, and orbital elements; physical characteristics of astronomical objects (Sun, planets, stars, galaxies), their internal structures and origins; the electromagnetic spectrum and methods for determining stellar temperatures; telescope types and detectors; stellar evolution and spectral classification; the structure of the Milky Way, properties of the interstellar medium, galaxy types and features, the structure of the galactic halo and magnetic field; fundamentals of modern cosmology, including the cosmological principle, cosmic microwave background, Universe models, dark matter, and dark energy[1]

- **be able to apply** physical laws and formulas (including Kepler's and Newton's laws) to describe and calculate celestial motions; analyze and explain observed astronomical phenomena (eclipses, parallax, planetary motions, spectral shifts); interpret data obtained in different electromagnetic ranges; use knowledge of stellar and galactic physics to explain their structure and energetics; employ telescopic and photometric observation methods; determine distances to astronomical objects and interpret redshift in the context of an expanding Universe (Hubble's law)[2]
- **possess skills** in working with the celestial sphere and coordinate systems, constructing diagrams; solving astrophysical problems using physical models; calculating stellar parameters (temperature, mass, luminosity, etc.); interpreting spectra to determine composition, temperature, and velocity; using astronomical databases and reference materials, analyzing and systematizing information; performing independent calculations and drawing conclusions based on theoretical and observational research; ensuring safety procedures during laboratory and observational work[3]

[1] knowledge; [2] skills; [3] abilities;

## Teaching and learning methods

Lectures; Problem solving; Self-study; Group work

## Admission requirements

Mandatory: No
Recommended: Knowledge of high school physics, mathematical analysis, and geometry

## Bibliography


1. Mamadazimov M. Umumiy astronomiya. T., 2008
2. Nuritdinov S.N., Tadjibayev I.U., Ziyaxanov R.F. // Umumiy astronomiyadan masalalar to‘plami // T., O‘zbekiston, 2013
3. Karttunen H. et al. Fundamental Astronomy. Springer, 2017, ISBN 978-3-662-53044-3


## Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| Type of Assessment | CA | FA |
|---|---|---|
| Timing | 30-31 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completion of sections related to lectures and problem solving, covering approximately half of the total material. The material is divided into variants, each containing 3 theoretical questions and 1 problem. Written answers are required. A maximum of 5 points is awarded for each correct answer.

**Final Assessment:** based on all covered topics. Each student receives a variant with 3 theoretical questions and 1 problem from the semester's material. Written answers are required, followed by oral responses to additional questions. A maximum of 5 points is awarded per answer. The final grade is the arithmetic mean.

## Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| OO2404 | Astrophysics of Variable Objects | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom activities (lecture review, solving exercises) | 30 h |
| Problem solving | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

Lecturers

Prof., Dr. Akhunov Talat

Course content

General information about stars: binary and multiple stars. Nature of star clusters and galaxies. Stellar motions. Apparent magnitudes. Distance, absolute magnitude, and luminosity. Stellar mass, spectrum, color, temperature, and radius. Information on stellar composition, rotation, and radial velocities. Hertzsprung–Russell diagram. Structure, formation, evolution, and final stages of stars. Variable stars: magnitudes and Julian days. Measurements of variable stars: discovery, observation, classification, and nomenclature. Rotating variables: spotted and solar-type stars. FK Comae, RS Canum, and BY Draconis stars. Peculiar A-type (Ap) stars. Pulsars. Eclipsing variable stars: general characteristics. Ellipsoidal variables. Classification and analysis of eclipsing stars. Detached, semi-detached, and contact binaries. Symbiotic binary systems. X-ray binaries. Evolution of binary systems. Exoplanet transits. Pulsating variables: pulsation modes, mechanisms, models. Nonlinear effects and non-equilibrium states. Helioseismology. Asteroseismology. Classical Cepheids. Rapidly oscillating peculiar stars. Pulsating red giants. Eruptive variables: flare stars, cataclysmic variables. Supernovae. Gamma-ray burst progenitors. Pre–main-sequence variables: T Tauri stars, FU Orionis objects, Herbig–Haro objects, Herbig Ae/Be stars. Other types of variable objects: Be stars, Wolf–Rayet stars, variable hypergiants. Active galactic nuclei: radio galaxies, quasars, blazars.

Learning objectives

Upon successful completion of this course, students should:

- possess knowledge and understanding of the fundamental characteristics of stars: mass, luminosity, spectrum, color, temperature, radius, chemical composition, rotation, and radial velocities; stellar classification (including binary and multiple systems), their internal structure, evolutionary stages, and end states; the Hertzsprung–Russell diagram and interrelations of stellar parameters; the concepts of apparent and absolute magnitude, luminosity, and distance, and methods of their determination; classification of variable stars (rotating, pulsating, eclipsing, eruptive, pre–main-sequence, etc.); the physical nature of pulsations and the basics of helio- and asteroseismology; features of eclipsing systems, cataclysmic variables, supernovae, gamma-ray burst progenitors, and other rare types of variables; properties of active galactic nuclei (radio galaxies, quasars, blazars) and their role in galaxy evolution[1]
- be able to classify variable stars according to brightness variations, spectral and physical features; distinguish mechanisms of variability (geometric, physical, gravitational, magnetic); explain the physical nature of various types of variable stars and their evolutionary roles; analyze properties of binary and multiple systems, including scenarios of mass transfer, accretion, and merging[2]
- possess skills in constructing, processing, and interpreting light curves of variable stars; working with variable star catalogs (e.g., GCVS, AAVSO), astronomical databases, and

visualization tools; interpreting photometric and spectroscopic data of variables from a scientific perspective; formulating hypotheses on the evolutionary states of objects based on observational data and models; applying knowledge of variable stars and active nuclei in a broader astrophysical context (stellar, galactic, and exoplanetary system evolution)[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Lectures; Problem solving; Self-study; Group work

Admission requirements

Mandatory: No
Recommended: Knowledge of high school physics, mathematical analysis, and geometry

Bibliography


1. Percy J.R. Understanding Variable Stars. Cambridge University Press, 2007
2. Francis Leblanc. An Introduction to Stellar Astrophysics. Wiley; 1 edition (May 17, 2010), ISBN-13: 978-0470699560
3. Сурдин В.Г. Звезды. М.: Физматлит, 2009 - 428 с.
4. Nuritdinov S.N., Tadjibayev I.U., Ziyaxanov R.F. // Umumiy astronomiyadan masalalar to‘plami // T., O‘zbekiston, 2013
5. Karttunen H. et al. Fundamental Astronomy. Springer, 2017, ISBN 978-3-662-53044-3


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 30-31 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completion of sections corresponding to lectures and problem solving, covering about half of the total material. The exam includes variants containing 3 theoretical questions and 1 problem. Answers are given in written form. Students may receive up to 5 points for each correct answer.

**Final Assessment:** based on all topics covered during the semester. Each student receives a variant including 3 theoretical questions and 1 problem. Answers are given in written form, followed by an oral examination. Students may receive up to 5 points for each answer. The final grade is determined as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| VT2404 | Vector and Tensor Analysis | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom activities (lecture review, solving exercises) | 30 h |
| Problem solving | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Nishonov Mukhtor

**Course content**

Scalar and vector quantities. Vector analysis. Scalars and vectors: definitions, rule of vector addition. Opposite vector. Zero vector. Basis vectors. Cartesian basis. Decomposition of vectors in a basis. Projection of a vector onto an axis. Linear dependence of vectors. Condition of linear independence of three vectors. Scalar, vector, mixed, and double products of vectors: definitions and calculations in the Cartesian coordinate system. Transition between two orthogonal bases. Transformation of vector components. Orthogonal transformations. Orthogonal matrices. Tensors and tensor analysis. General definition of a tensor. Transformation law of tensors under a change of coordinate system. Covariance of tensor equations. Examples. Tensor algebra: addition, multiplication, contraction. Symmetric and antisymmetric tensors. Kronecker delta. Criteria of tensorial nature of physical quantities. Proper and improper orthogonal transformations. Pseudotensors. Levi-Civita pseudotensor. Vector and tensor fields. Differentiation with respect to coordinates. Vector function of a scalar argument. Derivative of a scalar-argument function. Tensor field. Differentiation of a tensor field with respect to coordinates. Scalar field. Directional derivative. Gradient. Vector field. Field lines. Equation of vector lines. Flux of a vector field. Ostrogradsky–Gauss theorem for vector fields. Divergence of a vector field. Circulation of a vector field. Stokes' theorem for vector fields. Curl of a vector field. Basic vector differentiation operations: in vector form, Cartesian coordinates, and tensor notation. Second-order operations in vector analysis. Laplace operator. Hamiltonian. Line integrals of the 1st and 2nd kind. Fundamental theorem of vector analysis — Green's theorem. Green's formulas. Curvilinear coordinates. Definition of curvilinear coordinate systems. Lamé coefficients. Local basis. Cylindrical and spherical coordinate systems. Gradient, divergence, curl, and Laplacian in curvilinear coordinates.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge** of scalar and vector fields; Green's, Ostrogradsky–Gauss, and Stokes' theorems; the concepts of gradient, divergence, curl, and Laplace operator; basic operations of vector analysis in curvilinear coordinate systems; tensors and tensor transformations under a change of basis in linear space[1]
- **be able to apply** vector and tensor analysis in professional activities to solve problems in physics, scientific research, and engineering; analyze the obtained results[2]
- **possess practical skills** in applying the acquired knowledge for problem solving, and correctly use the methods of vector and tensor analysis in relevant professional fields[3]

[1] knowledge; [2] skills; [3] abilities;

| Teaching and learning methods |
|---|
| Lectures; Problem solving; Self-study; Group work |
| **Admission requirements** |
| Mandatory: No<br>Recommended: Mathematical Analysis, Linear Algebra and Analytic Geometry, basic knowledge of Complex Numbers. |
| **Bibliography** |
| 1. Маллин Р.Х. Майдон назарияси. «Ўқитувчи» нашриёти, Тошкент, 1965.<br>2. Любимов Д. В. Тензорный анализ. Методические указания. Ч. 1 - 2, 1987.<br>3. Позняк Э. Г., Шикин Е. В. Дифференциальная геометрия. М.:Изд - во МГУ, 1990. |
| **Assessments** |
| Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.<br><br>**Type of Assessment** — **CA**: Timing: 11 th week; Form of Assessment: written exam — **FA**: Timing: 19 th week; Form of Assessment: written and oral exam<br><br>**Continuous Assessment:** conducted after completion of sections corresponding to lectures and problem solving, covering about half of the course. The exam includes 3 theoretical questions and 1 problem per variant. Answers are written. Students may receive up to 5 points per correct answer.<br>**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions and 1 problem. Answers are given in written form, followed by an oral examination. Students may receive up to 5 points per answer. The final grade is determined as the arithmetic mean. |
| **Educational Materials and Media Tools** |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| ZF2404 | Modern Fortran | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom activities (lecture review, solving exercises) | 30 h |
| Problem solving | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Nishonov Mukhtor

**Course content**

Basic elements of the Fortran language. Syntax. Data types. Simple input/output operations. Program structure. Variables and constants, their declaration. Operators and expressions. Expression operations. Arithmetic, logical, bitwise, and comparison operations. Type conversion. Order of precedence. Conditional statements. Switch statement. Loop constructs: break and continue. Built-in functions and subroutines. Subroutines: functions, procedures, modules. Complex data types. Arrays and their declaration. Working with arrays. Using arrays as subroutine parameters. Strings, string values, and string variables. String representation in memory. String operations. Files and file operations. Dynamic memory allocation. Pointers. Variable-size arrays. Lists, queues, stacks, dictionaries. Additional language features: compiler options, templates.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the core elements of Fortran: syntax, program structure, data types, rules for declaring variables and constants; operators and expressions, arithmetic, logical, bitwise, and comparative operations; type conversion rules and operation precedence; conditional and looping constructs, break and continue statements; features of built-in functions and subroutines (functions, procedures, modules); working with arrays and strings, their memory representation and operations; file handling, dynamic memory allocation, pointers, and variable-size arrays; composite data structures (lists, queues, stacks, dictionaries); additional features such as templates and compiler options[1]
- **be able to develop and debug** Fortran programs using modern language constructs; apply conditional, branching, and looping operators for computation automation; use built-in functions and subroutines to enhance modularity and code reuse; declare and effectively use arrays and strings in algorithms of varying complexity; handle files in text and binary formats; apply dynamic memory allocation and pointers in practical tasks; analyze program behavior, detect errors, and optimize code[2]
- **possess practical skills** in applying Fortran to solve problems in physics, scientific research, and engineering; use the language in professional activities; correctly apply modern features of Fortran to specific tasks; demonstrate independence in choosing programming tools and approaches for algorithm implementation[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work

**Admission requirements**

Mandatory: No

Recommended: Mathematical Analysis, Linear Algebra and Analytic Geometry, Computer Modeling of Physical Processes.

Bibliography


1. Нишонов М.М., Замонавий Фортран, 2022, Тошкент
2. Бартеньев О. Современный Фортран, 2005, Диалог-МИФИ
3. Немнюгин С., Стесик О. Современный Фортран, 2004, БХВ-Петербург
4. Hermanns M. Parallel Programming in Fortran 95 using OpenMP, http://www.openmp.org
5. Горелик Ф. Средства поддержки параллельных вычислений в стандартах языка Фортран, 2012, Препринт ИПМ им. М.В. Келдыша, No 68.


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 11 th week | 19 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completion of lecture and problem-solving sections covering half of the course. The exam consists of 3 practical tasks to be solved directly on a computer. Students may receive up to 5 points per correct solution.

**Final Assessment:** based on all topics covered. Each student receives a variant with 3 practical tasks to be solved on a computer. Within 2 hours, students must write programs that yield correct results for given test conditions. Up to 5 points are awarded for each correct program. The final grade is the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| FE2404 | Physical Electronics | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions (review of lecture material, preparation for seminars) | 30 h |
| Seminars | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Rakhmonov Ganiboy

**Course content**

High vacuum generation in physical electronics. Vacuum creation and its gradations. Vacuum measurement. Measuring instruments. Gas discharge. Gas-discharge electronics. Motion of charged particles in gases. Processes in gas-discharge plasma. Franck–Hertz experiment. Klein and Rosseland theory. Elastic and inelastic collisions of atomic particles. Electronic theory of solids. Models of free, weakly bound, and strongly bound electrons. Electron emission in solids and its types. Fundamental equation of thermionic emission. Dependence of saturation current on temperature and work function of metals. Methods of work function determination. Photoelectron emission. External photoelectric effect in metals. Fowler–Nordheim theory of field emission in metals. Secondary electron emission and its fundamental laws. Energy distribution of secondary electrons, emission coefficients, and their technical applications.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the principles of high-vacuum generation and measurement; physical foundations of gas discharge and its electronic characteristics; interactions of charged particles with gases and plasma; key experimental data and theoretical models (Franck–Hertz experiment, Klein and Rosseland theory); models of the electronic structure of solids (free, weakly, and strongly bound electrons); types of electron emission – thermionic, photo-, field, and secondary; the thermionic emission equation, Fowler–Nordheim theory, and methods of determining the work function[1]
- **be able to apply** electron motion models in vacuum and gases to analyze physical processes; calculate emission parameters under various conditions; analyze interactions of electrons with matter, including collisions and emission phenomena; interpret experimental data on electron emission and vacuum systems[2]
- **possess practical skills** in operating vacuum equipment and measuring instruments; apply knowledge of emission physics in engineering and scientific activities; use acquired knowledge and skills to solve applied problems in electronics, instrumentation, and solid-state physics[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work

**Admission requirements**

Mandatory: No
Recommended: Electricity and Magnetism

Bibliography


1. Рахмонов Ғ.Т., Норқулов Н. Электронлар ва ионлар эмиссияси: Ўқув қўлланма, Тошкент, ЎзМУ, 2023, 120 бет.
2. Элмуродов Р.У., Нурматов Н.А., Норқулов Н., Рахмонов Ғ.Т. “Вакуум физикаси ва техникаси” Тошкент. 2023 й. 200 б.
3. Nurmatov N., Buribaev I. «Qattiq jismlarda fotoelektron emissiyani o‘rganish». Toshkent, O‘zMU, 2000.


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completion of sections corresponding to lectures and problem solving, covering about half of the course. The exam consists of 3 theoretical questions per variant. Answers are written. Students may receive up to 5 points per correct answer.

**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions. Answers are written, followed by an oral examination. Students may receive up to 5 points per answer. The final grade is determined as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| EA2404 | Physical Foundations of Emission and Absorption Processes | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions (review of lecture material, preparation for seminars) | 30 h |
| Seminars | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Rakhmonov Ganiboy

**Course content**

High vacuum generation in physical electronics. Vacuum creation and its gradations. Nature of metal surfaces. Inhomogeneous surfaces: physical heterogeneity. Introduction to the electronic theory of solids. Emission phenomena. Thermionic emission. Methods of work function determination. Photoelectron emission. Fowler–Nordheim theory of field emission in metals. Fundamental regularities of secondary electron emission in metals. Energy distribution of secondary electrons. Energetics of surface processes. Heat of adsorption in weak chemisorption. Heat of adsorption in strong chemisorption. Binding forces in interactions of atoms and molecules with solid surfaces. Van der Waals forces. Exchange forces. Heteropolar binding forces.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the principles of vacuum creation and gradation in physical electronics; features of metal surface structure and physical inhomogeneity; fundamentals of electronic theory of solids; mechanisms of thermionic, photoelectric, and field emission; Fowler–Nordheim theory and regularities of secondary emission; nature of secondary electron energy distribution; thermodynamics of adsorption processes in weak and strong chemisorption; types of binding forces: van der Waals, exchange, and heteropolar[1]
- **be able to explain** the physical nature of emission phenomena; apply methods for determining electron work function; interpret energetic processes on solid surfaces; use basic models of particle–surface interaction; compare the characteristics of different types of emission under experimental conditions; analyze the physical aspects of chemisorption and adsorption[2]
- **possess practical skills** in applying vacuum techniques in physical and technical setups; calculating emission and surface processes; working with physical models for analyzing electronic and adsorption phenomena; interpreting experimental data obtained in solid-surface studies[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work

**Admission requirements**

Mandatory: No
Recommended: Electricity and Magnetism

Bibliography


1. Рахмонов Ғ.Т., Норқулов Н. Электронлар ва ионлар эмиссияси: Ўқув қўлланма, Тошкент, ЎзМУ, 2023, 120 бет.
2. Р.У. Элмуродов, Н.А. Нурматов, Н.Норқулов, Ғ.Т.Рахмонов. “Вакуум физикаси ва техникаси” Тошкент. 2023 й. 200 б.
3. Векслер В.И. Электрон эмиссия. Ташкент, ТашГУ, 1993
4. N.Nurmatov, I.Buribaev. «Qattiq jismlarda fotoelektron emissiyani o‘rganish». Toshkent, O‘zMU, 2000


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completion of sections corresponding to lectures and problem solving, covering about half of the course. The exam consists of 3 theoretical questions per variant. Answers are written. Students may receive up to 5 points per correct answer.

**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions. Answers are written, followed by an oral examination. Students may receive up to 5 points per answer. The final grade is determined as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| YF2504 | Fundamentals of Semiconductor Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 5 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions | 30 h |
| Problem solving | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Nasirov Abdumannop; Associate Prof., Dr. Parchinskiy Pavel;

**Course content**

Semiconductors in modern science and technology. Classification of materials by specific resistivity. Mechanism of electrical conductivity in semiconductors. Schrödinger equation for a crystal. Brillouin zones. Effective mass of charge carriers. Intrinsic and doped semiconductors. Vibrations of atoms in a crystal lattice. Heat capacity of the crystal lattice. Statistics of electrons and holes in semiconductors. Scattering mechanisms of charge carriers in semiconductors. Types of scattering centers. Scattering by impurity ions and dislocations. Kinetic phenomena in semiconductors. Hall effect. Galvanomagnetic, thermoelectric, and thermomagnetic effects. Generation and recombination of nonequilibrium charge carriers. Types of recombination. Diffusion and drift of charge carriers. Einstein relation. Contact phenomena in semiconductors. Work function. Metal–metal and metal–semiconductor contacts. Ohmic junctions, $n–n^+$ and $p–p^+$ junctions. Heterojunctions. Schottky barrier. Theory of forward current and diffusion theory. Contact between n-type and p-type semiconductors. Surface phenomena in semiconductors. Space charge theory. Surface recombination. Photoelectric properties of semiconductors. Photoconductivity. Intrinsic absorption in direct and indirect transitions. Exciton absorption. Thermoelectric phenomena in semiconductors. Seebeck effect, Peltier effect, electrothermal effect. Properties of thin films: metallic, epitaxial, dielectric, and ferromagnetic films.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the physical nature of conductivity in intrinsic and doped semiconductors; band structure and the concept of effective mass; scattering and recombination mechanisms of charge carriers; fundamentals of thermoelectric, photoelectric, and galvanomagnetic effects; physics of contact phenomena, including Schottky barriers and heterojunctions; properties of thin films of various types and their applications[1]
- **be able to apply** quantum-mechanical and statistical models to describe processes in semiconductors; interpret semiconductor behavior under various physical conditions (temperature, illumination, magnetic field); calculate parameters of conductivity, carrier concentrations, diffusion length, saturation current, and recombination; analyze and explain experimental data using semiconductor physics[2]
- **possess practical skills** in analysis and calculations for the design and evaluation of semiconductor devices; application of knowledge in solving applied problems in electronics, nanotechnology, energy, and materials science; use of methods for evaluating material characteristics and contact junctions for specific technical solutions[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

| Admission requirements |
|---|
| Mandatory: No<br>Recommended: Electricity and Magnetism |
| **Bibliography** |
| 1. Zaynobidinov S., Teshaboev A.T. Yarimo‘tkazgichlar fizikasi. T.: «O‘qituvchi», 1999.<br>2. M. K. Baxodirxonov, N. F. Zikirillayev, X. M. Iliyev. Yarimo‘tkazgichlar fizikasi. 2016.<br>3. Teshaboev A.T., Zaynobidinov S., Ermatov Sh. Kattiq jism fizikasi. T.: «Moliya», 2001.<br>4. Shalimova K.V. Fizika poluprovodnikov. M. Energiya. 1976.<br>5. Marius Grundmann. Physics of Semiconductors. Leipzig, Springer, 2010.<br>6. S. M. Sze and Kwok K. Ng. Physics of Semiconductor devices, Wiley, 2007. |
| **Assessments** |
| Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.<br><br>**Type of Assessment** — **CA** — **FA**<br>Timing — 9-10 th week — 19-20 th week<br>Form of Assessment — written exam — written and oral exam<br><br>**Continuous Assessment:** conducted after completion of sections corresponding to lectures and problem solving, covering about half of the course. The exam consists of variants with 3 theoretical questions and 1 problem. Answers are written. Students may receive up to 5 points per correct answer.<br>**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions and 1 problem on the topics studied during the semester. Answers are written, followed by an oral examination. Students may receive up to 5 points per answer. The final grade is determined as the arithmetic mean. |
| **Educational Materials and Media Tools** |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| YA2504 | Physics of Semiconductor Devices | | |
|---|---|---|---|
| | | | |
| Academic semester | 5 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions | 30 h |
| Problem solving | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Nasirov Abdumannop; Associate Prof., Dr. Parchinskiy Pavel;

**Course content**

System of fundamental equations for analyzing semiconductor device operation. Metal–semiconductor contact. Work function. Richardson's formula. Schottky barrier. Ohmic contacts. Current–voltage characteristics (I–V curves) of contacts. Formation of the p–n junction. Distribution of charge carriers in the p–n junction. Band diagrams. Calculation of the width of an ideal junction. Diffusion and drift currents in p–n junctions. Current–voltage characteristics of junctions. Types of diodes. Transport processes in the p–n junction. Diode characteristics. Principles of bipolar transistor operation. Band diagrams. Calculation of base, emitter, and collector currents. Efficiency of emitter and collector junctions. Current gain factor. Calculation of transistor parameters using perturbation theory. Statistical characteristics of bipolar transistors. Metal–insulator–semiconductor structures. Band diagrams. Conductivity of the surface layer of semiconductors. Field-effect transistors with insulated gate (MOSFETs). Types of MOSFETs and their structural and technological features. Four-layer structures. Dynistors: operating principle and main characteristics. Thyristors and triacs. Calculation of current–voltage characteristics. Fabrication methods and applications. Junction field-effect transistors (JFETs). Operating principle. Methods for calculating key characteristics. Transconductance. Applications of JFETs.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding of** the physical principles of operation of major semiconductor devices (diodes, transistors, thyristors, triacs, etc.); structure, band diagrams, and operating modes of p–n and heterojunctions; principles of ohmic and barrier contacts; features of drift and diffusion currents; definitions and properties of scalar and vector fields in the context of electrophysical processes in semiconductors[1]
- **be able to construct** band diagrams and use them to analyze device operation; calculate transistor currents and parameters; determine current gain, transconductance, and other key parameters; evaluate the influence of design and fabrication technology on device characteristics[2]
- **possess practical skills** in measuring current–voltage characteristics (I–V curves), analyzing and interpreting experimental data; identifying physical causes of deviations from theoretical models; using I–V curves in the design, modeling, and analysis of circuits containing semiconductor components[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Electricity and Magnetism

Bibliography


1. Zaynobidinov S., Teshaboev A.T. Yarimo‘tkazgichlar fizikasi. T.: «O‘qituvchi», 1999.
2. M. K. Baxodirxonov, N. F. Zikirillayev, X. M. Iliyev. Yarimo‘tkazgichlar fizikasi. 2016.
3. Teshaboev A.T., Zaynobidinov S., Ermatov Sh. Kattiq jism fizikasi. T.: «Moliya», 2001.
4. Shalimova K.V. Fizika poluprovodnikov. M. Energiya. 1976.
5. Marius Grundmann. Physics of Semiconductors. Leipzig, Springer, 2010.
6. S. M. Sze and Kwok K. Ng. Physics of Semiconductor devices, Wiley, 2007.


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 9-10 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** conducted after completion of sections corresponding to lectures and problem solving, covering about half of the course. The exam consists of variants with 3 theoretical questions and 1 problem. Answers are written. Students may receive up to 5 points per correct answer.

**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions and 1 problem on the topics studied during the semester. Answers are written, followed by an oral examination. Students may receive up to 5 points per answer. The final grade is determined as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| IN2604 | Interaction of Ionizing Radiation with Matter | | |
|---|---|---|---|
| | | | |
| Academic semester | 6 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions (review of lecture material, preparation for seminars) | 30 h |
| Seminars | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Polvonov Satimboy

**Course content**

The necessity of studying particle penetration through matter and its practical applications. Interaction of nuclear radiation with matter. Passage of heavy charged particles through matter. Passage of light charged particles through matter. Vavilov–Cherenkov radiation. Interaction of gamma radiation with matter. Interaction of neutrons with matter. Neutron moderation. Characteristics of a radiation field. Fluence of ionizing particles. Flux density of ionizing particles. Energy fluence of ionizing particle flux. Dosimetric characteristics of radiation fields. Absorbed dose of ionizing radiation. Exposure dose and its unit of measurement. Equivalent dose and its unit. Effective dose and its unit. Dose rate. Biological effects of ionizing radiation and permissible limits. Radiation protection measures. Practical session: types of shielding. Organization of radiation protection. Protection against gamma radiation. Protection against α- and β-radiation. Shielding against neutron flux. Permissible levels of α- and β-radiation in workplaces. Radioactive waste. Radiation level determination. Devices for radiation measurement. Instruments for measuring gamma radiation. Instruments for measuring α- and β-radiation.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the main types of ionizing radiation and their characteristics; mechanisms of radiation interaction with matter; physical principles of charged and neutral particle penetration; concepts of fluence, flux density, and energy fluence in radiation measurements; dosimetric quantities (absorbed, exposure, equivalent, and effective doses) and their units; radiation safety standards and biological consequences of ionizing radiation exposure[1]
- **be able to** perform quantitative assessment of radiation field parameters; calculate dose loads for different types of radiation; use dosimetric and radiometric instruments; design and justify radiation protection measures[2]
- **possess practical skills** in measuring gamma, alpha, and beta radiation levels; applying radiation safety knowledge in laboratory and industrial settings; assessing radiation environments and implementing protective measures[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work

**Admission requirements**

Mandatory: No

Recommended: Electricity and Magnetism

Bibliography


1. Черняев А.П. Взаимодействие ионизирующего излучения с веществом. – М.: ФИЗМАТЛИТ, 2004. -152 с.
2. Мухин К.Н. Экспериментальная ядерная физика,т.1,2. М.: Энергоатомиздат, 1983.
3. Кадилин В.В., Милосердин В.Ю., Самосадный В.Т. Прикладная ядерная физика. Учебное пособие. М.: МИФИ, 2007.
4. Каюмов М.А. Дозиметрия асослари ва ионлаштирувчи нурланишлардан ҳимояланиш. Т.: Давр, 2013.


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** after completion of sections covering lectures and problem solving, approximately half of the course. Variants include 3 theoretical questions. Written answers are required. Students may receive up to 5 points per correct answer.

**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions from the semester's topics. Written answers are required, followed by oral questioning. Students may receive up to 5 points per answer. The final grade is the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| KE2604 | Medical Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 6 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions (review of lecture material, preparation for seminars) | 30 h |
| Seminars | 30 h | Literary Studies (preparation of a term paper, completion of homework) | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Polvonov Satimboy

**Course content**

Introduction. History and stages of development of medical physics. Fundamentals of biomechanics: muscle work, ergometry, mechanical processes in the musculoskeletal system. Hydrodynamics and hemodynamics: blood as a viscoplastic fluid, work and power of the heart. Classification of electromedical equipment and principles of operation. Medical technical devices. Bioacoustics. Physical principles of sound and ultrasound use in medicine. Infrasound: its characteristics and biological effects. Biological electrodynamics: galvanization and electrophoresis. Transport processes in biological systems. Biological membranes and their physical properties. Circulation. Artificial circulation. Cardiovascular system and the importance of blood flow. Fundamentals of quantum biophysics. X-rays and their applications in medicine. Radiobiology, radioactivity, law of radioactive decay. Effects of ionizing radiation on the human body. Applications of ionizing radiation in medicine.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the physical foundations of biomechanics, hemodynamics, and bioacoustics; principles of medical and electromedical devices; properties and effects of infrasound and ultrasound; basics of biological electrodynamics (including galvanization and electrophoresis); physics of biological membranes and transport processes; physical principles of X-rays, radioactivity, and their applications in medicine; biological effects of ionizing radiation and principles of its diagnostic and therapeutic use[1]
- **be able to** apply physics knowledge to analyze biological and physiological processes; interpret principles of diagnostic and therapeutic devices; evaluate physical effects of medical equipment on the human body; analyze data and measurements obtained with medical instruments[2]
- **possess practical skills** in applying physical knowledge in medical practice and biophysical research; using technical tools and devices for solving medical physics problems; correctly interpreting physical parameters and data in clinical and research contexts[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work

**Admission requirements**

Mandatory: No

Recommended: Electricity and Magnetism

Bibliography


1. Ремизов А. Н. Медицинская и биологическая физика: учебник / Ремизов А.Н. – 4-е изд., испр. и перераб. – М., 2013. http://www.studmedlib.ru.
2. Ремизов А.Н. Сборник задач по медицинской и биологической физике : учебное пособие для студентов высших учебных аведений, обучающихся по медицинским специальностям : – М.: Дрофа, 2010.
3. Bazarbayev M.I., Mullajonov I., Sobirjonov A.Z., Abdujabborova U.M., Djurayev A.S. Tibbiyot texnikasi va yangi tibbiyot texnologiyalari. Darslik. -Toshkent. 2022 y.
4. Bazarbayev M.I., Mullajonov I., Saidnazarova I.Sh., Abdujabborova U.M., Sobirjonov A.Z. Tibbiy elektronika. Darslik. -Toshkent. “IJOD-PRINT” 2019 y
5. Umarov S.X., Bozorov E.X., O.I.Jabborova. tibbiy texnika va yangi tibbiy texnologiyalar. Toshkent. Iqtisod-moliya. 2019 y. 215 b.
6. Xomidjonov J.I., Xojiyev Sh.E., Bozorov E.X., Xojiyeva M.E., Tursunboyev Q.N., Tibbiyot fizikasi asoslari. Darslik. Farg‘ona. Classik nashriyot. 2023 y. 303 b.


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 27-28 th week | 36-37 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** after completion of sections covering lectures and problem solving, approximately half of the course. Variants include 3 theoretical questions. Written answers are required. Students may receive up to 5 points per correct answer.

**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions from the semester’s topics. Written answers are required, followed by oral questioning. Students may receive up to 5 points per answer. The final grade is the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| LF2604 | Laser Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions (review of lecture material, preparation for seminars) | 30 h |
| Seminars | 30 h | Preparation of course project. | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Eshonkulov Gafurjan

**Course content**

The discipline "Laser Physics," its goals and applications. Development of lasers and their use in various fields. Principles of laser operation and their properties. Physical principles of laser devices. Stimulated and spontaneous transitions. Einstein coefficients. Conditions for generation. Three- and four-level lasers. Laser operation modes: continuous-wave and giant pulse modes. Pumping methods and schemes. Basic theory of optical resonators. Elementary theory of open-resonator modes. Physical principles of frequency conversion of laser radiation. Maxwell's equations in nonlinear media. Tensor of nonlinear polarizability. Polarization of dielectrics under low- and high-intensity laser radiation. Second harmonic generation. Phase matching. Coherence length. Mode-locking and generation of picosecond pulses. Methods of measuring pulse duration. Concept of femtosecond pulses. Rayleigh and Raman scattering. Stimulated Raman and Brillouin scattering. Fundamentals of multiphoton spectroscopy. Two-photon absorption in absorbing transparent media. Solving the equation for two-photon absorption.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of physical principles of laser operation, including stimulated and spontaneous transitions, energy levels and generation conditions; laser devices and operating regimes; principles of laser emission formation, amplification, and modulation; main phenomena of nonlinear optics (second harmonic generation, phase matching, multiphoton absorption); Maxwell's equations for nonlinear media and nonlinear polarizability tensor; scalar and vector field descriptions in electromagnetic radiation[1]
- **be able to** apply vector and tensor analysis to describe processes in laser systems; calculate generation and amplification parameters; analyze laser operating modes; describe nonlinear light–matter interactions; interpret multiphoton spectroscopy results and solve equations for two-photon absorption[2]
- **possess practical skills** in analysis and calculation of laser and component characteristics; applying knowledge in professional, engineering, and research contexts; using methods for calculating and measuring ultrashort pulse and nonlinear optical process parameters[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Electricity and Magnetism, Optics

Bibliography


1. Звельто О. Принципы лазеров.-СПб,: Изд. Лань, 2008.
2. G'.Eshonqulov, R.Vildanov, M.Qosimjonov Lazer fizikasi va nochiziqli optika asoslari. T. Universitet, 2022 y. 244 b
3. М.М.Мириноятов "Лазерлар физикаси ва техникаси" Т.Университет, 2009
4. Дмитриев В. Г., Тарасов Л. В. Прикладная нелинейная оптика. — 2-е изд., перераб. и доп. — М.: ФИЗМАТЛИТ, 2004. — 512 с.
5. Wolfgang Demtröder. Laser Spectroscopy. Springer. 2008


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 9-10 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** after completion of sections covering lectures and problem solving, approximately half of the course. Variants include 3 theoretical questions. Written answers are required. Students may receive up to 5 points per correct answer.

**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions from the semester's topics. Written answers are required, followed by oral questioning. Students may receive up to 5 points per answer. The final grade is the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| AO2604 | Applied Optics | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions (review of lecture material, preparation for seminars) | 30 h |
| Seminars | 30 h | Preparation of course project | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Kasimov Abdugappar

**Course content**

The role of applied optics in physics and related sciences. Applications of modern spectroscopic and molecular-optical methods in science, technology, and practice. Classification of spectroscopic instruments. Main characteristics of spectroscopic instruments, optical schemes, and operating principles. Instrumental function and its definition. Influence of instrumental function on results. Modern methods of accounting for instrumental function in optical research. Prism spectrometers: design, characteristics, instrumental function, and applications. Advantages and disadvantages. Transmission diffraction gratings in spectrometers: instrumental function and applications. Reflective diffraction gratings in spectrometers. Concave reflective gratings. High-resolution spectrometers. Lummer plate. Michelson echelon. Fabry–Perot interferometer. Spectral line broadening and mechanisms. Spectrometers for the infrared range: Fourier interferometers. Radiation sources in spectroscopy and their characteristics. Photoelectric detectors: principles and characteristics.

**Learning objectives**

Upon successful completion of this course, students should:

- possess knowledge and understanding of the main types and functions of applied optics in physics and related sciences; classification and design of spectroscopic instruments; operating principles of prism, diffraction, and interference devices; physical meaning of the instrumental function and its role in spectral measurements; types of radiation sources and photodetectors used in optical research; definitions and behavior of scalar and vector fields in optical processes[1]
- be able to apply vector and tensor analysis in interpreting spectral data and building optical models; analyze and compare spectroscopic instrument characteristics for practical and research tasks; account for the influence of instrumental function in calculations and data processing[2]
- possess practical skills in selecting and using optical instruments for laboratory and applied tasks; applying knowledge in professional and research practice; working with radiation sources and photodetectors and evaluating their suitability for various spectroscopic applications[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Seminars; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Electricity and Magnetism, Optics

**Bibliography**

1. Е. М. Гоголева, Е. П. Фарафонтова Прикладная оптика Учебное пособие. Екатеринбург Издательство Уральского университета 2016.
2. Золотарев В.М., Никоноров Н.В., Игнатьев А.И. Современные методы исследования оптических материалов. Учебное пособие, Санкт – Петербург, ИТМО, 2013
3. Зайдель А.Н., Островская Г.В., Островский Ю.И. Техника и практика спектроскопии. М.1976.
4. Скоков И.В. Оптические спектральные приборы. М.1984 г.

Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 9-10 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** after completion of sections covering lectures and problem solving, approximately half of the course. Variants include 3 theoretical questions. Written answers are required. Students may receive up to 5 points per correct answer.

**Final Assessment:** based on all topics covered. Each student receives a variant with 3 theoretical questions from the semester's topics. Written answers are required, followed by oral questioning. Students may receive up to 5 points per answer. The final grade is the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| PF2704 | Fundamentals of Polymer Physics | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom and laboratory sessions | 30 h |
| Laboratory work | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Jakhongir Khakkulov

**Course content**

Molecular structure of polymers. Natural and synthetic polymers. Types of polymerization. Physical properties of macromolecules. Conformational characteristics and macromolecular models. Thermodynamic and kinetic segments. Flexibility. Mass characteristics of macromolecules. Molar, absolute, relative, and average molecular weights. General properties of amorphous polymers: glass transition, elasticity, viscosity, fracture. Elastomers. Relaxation processes. Crystalline state of polymers: conditions of crystallization, thermodynamic and kinetic foundations. Liquid-phase polymer systems. Structural and phase transitions. Dilute, concentrated solutions, and mixtures. Phase diagrams, theta-temperature, equation of state. Flory–Huggins parameter and solvent quality. Polyelectrolytes and gels. Hydrodynamics and rheology of polymers. Newtonian and non-Newtonian fluids. Polymer morphology and their special properties: mechanical, thermal, and optical anisotropy. Sorption. Polymer composites and nanosystems.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of molecular structure, types, and properties of natural and synthetic polymers; types of polymerization and the physicochemical features of macromolecule formation; conformational and thermodynamic characteristics of polymers; relaxation mechanisms and phase transitions; properties of amorphous and crystalline states; principles of hydrodynamics and rheology of polymers; morphological and anisotropic characteristics; solubility parameters, phase diagrams, and polymer behavior in solutions and mixtures[1]
- **be able to** classify polymers by structure, origin, and physicochemical properties; apply methods of calculating molecular weights and other macroscopic parameters; analyze physical processes in polymer systems, including relaxation, glass transition, and crystallization; use hydrodynamic and rheological models to describe polymer behavior[2]
- **possess practical skills** in evaluating physicochemical properties of polymers; applying knowledge in laboratory and engineering tasks related to material development; interpreting experimental data and applying it in professional practice; selecting models and methods for describing polymer systems in applied physics, chemistry, and materials science[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Laboratory work; Self-study; Group work;

**Admission requirements**

Mandatory: No

Recommended: Basic high-school level knowledge of chemistry, physics, and mathematics

Bibliography


1. Xolmuminov A.A. Polimerlar fizikasi. O'quv qo'llanma. – Tashkent. :Universitet. – 2015. -252 b.
2. Mamadalimov A.T., Rashidova S.SH., Xolmuminov A.A. Polimer tolalar fizikasi. O'quv qo'llanma. – Toshkent. :Universitet. – 2009. -124 b.
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5. Бартенев Г.М., Френкель С.Я. Физика полимеров.-Л.:Химия,1990.-432 с.


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 11 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Assessment Criteria:**

**Grade "5" (excellent):**

- student must fully disclose the content of the discipline;
- present topics with a logical and scientific approach without errors;
- demonstrate clear understanding of theoretical and practical significance;
- show ability for independent and critical thinking;
- provide precise and concise answers;
- maintain well-prepared notes; complete independent tasks thoroughly and accurately;
- publish a scientific article on one of the course topics.

**Grade "4" (good):**

- student must understand the essence and content of the discipline without scientific or logical errors;
- recognize practical significance;
- complete exercises within the curriculum; give correct answers;
- maintain properly prepared notes; complete independent tasks.

**Grade "3" (satisfactory):**

- student must have a general understanding of the subject;
- present topics briefly with some inconsistencies;
- demonstrate fragmented reasoning;
- provide incomplete answers;
- keep poorly structured notes.

**Grade "2" (unsatisfactory):**

- student is unprepared for classes;
- has no understanding of the subject;
- work shows plagiarism;
- contains serious mistakes and confusion;
- unable to answer questions;
- lacks basic knowledge of the discipline.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| PK2704 | Fundamentals of Polymer Physics and Chemistry | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom and laboratory sessions | 30 h |
| Laboratory work | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Associate Prof., Dr. Jakhongir Khakkulov

**Course content**

Composition of polymers, monomers, repeating units, linear and network structures, regular chains, molecular weights, configuration, conformation, flexibility, macromolecular models, segments. Production of natural and synthetic polymers. Synthesis of natural polymers. Physical effects, configurational and conformational changes and modifications. Chemical modifications: types and applications. Physicochemical, mechanochemical, and reaction chemistry of polymers. Phase, physical, and relaxation states of polymers. Polymer systems in solid phase. Amorphous–crystalline states. Polymer systems in liquid phase. Phase diagrams. Dilute, medium-concentration, and highly concentrated solutions. Polyelectrolytes, gels, liquid crystals. Emulsions, suspensions, colloidal and nanoscale systems. Structural and phase transformations of polymers under flow. Orientation and crystallization of polymers. Polymer nanosystems and nanomaterials. Anisotropy of polymers and their functionally active properties.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of molecular structure and composition of polymers; classification by bonding type and chain structure; basic concepts (monomer, repeating unit, configuration, conformation, flexibility, segment); principles of natural and synthetic polymer synthesis; physical and chemical modifications of polymers; phase transitions, aggregate states, and relaxation in polymer systems; properties and classification of polymer solutions, gels, liquid crystals, emulsions, colloids, and nanosystems[1]
- **be able to** analyze phase, structural, and dynamic characteristics of polymer systems; use macromolecular models to describe their properties and external response; assess effects of chemical modifications on polymer physicochemical properties; interpret phase diagrams and perform related calculations; process and analyze experimental data obtained from polymer research[2]
- **possess practical skills** in working with polymeric materials, including synthesis and modification; methods of analyzing relaxation and phase processes; applying knowledge in materials science, chemical technology, solid-state physics, and nanotechnology[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Laboratory work; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Basic high-school level knowledge of chemistry, physics, and mathematics

**Bibliography**

1. Xaqqulov J.M., Temirov Z.Sh. Polimerlar fizikasi asoslari. O'quv qo'llanma. –Toshkent. :Ma'rifat.-2025. 240 b.
2. Xolmuminov A.A. Polimerlar fizikasi. O'quv qo'llanma. Tashkent. :Universitet. – 2015. -252 b.
3. William D. Callister Jr. Materials Sciences and Engineering. An Introduction. John Wiley & Sons. Ins. 2010. – P. 1000.
4. Mamadalimov A.T., Rashidova S.Sh., Xolmuminov A.A. Polimer tolalar fizikasi. O'quv qo'llanma. – Toshkent. :Universitet. – 2009. -124 b.
5. Tager A.A. Fiziko-ximiya polimerov M.:Nauchnыy Mir, 2007. -576 s.

## Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| Type of Assessment | CA | FA |
|---|---|---|
| Timing | 11 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Assessment Criteria:**

**Grade "5" (excellent):**

- student must fully disclose the content of the discipline;
- present topics with a logical and scientific approach without errors;
- demonstrate clear understanding of theoretical and practical significance;
- show ability for independent and critical thinking;
- provide precise and concise answers;
- maintain well-prepared notes; complete independent tasks thoroughly and accurately;
- publish a scientific article on one of the course topics.

**Grade "4" (good):**

- student must understand the essence and content of the discipline without scientific or logical errors;
- recognize practical significance;
- complete exercises within the curriculum; give correct answers;
- maintain properly prepared notes; complete independent tasks.

**Grade "3" (satisfactory):**

- student must have a general understanding of the subject;
- present topics briefly with some inconsistencies;
- demonstrate fragmented reasoning;
- provide incomplete answers;
- keep poorly structured notes.

**Grade "2" (unsatisfactory):**

- student is unprepared for classes;
- has no understanding of the subject;
- work shows plagiarism;
- contains serious mistakes and confusion;
- unable to answer questions;

lacks basic knowledge of the discipline.

## Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| QJ2704 | Solid State Physics | | |
|---|---|---|---|
| Academic semester | 7 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions | 30 h |
| Problem solving | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Isayev Makhmud; Associate Prof., Dr. Parchinskiy Pavel;

**Course content**

Occurrence of solids in nature. Objectives and scope of *Solid State Physics*. General properties of solids. Structure of solids. Types of crystal symmetries. Crystal structure of matter. Amorphous state of matter. Electrical properties of solids. Main characteristics of electrical conductivity. Energy bands in solids. Charge carrier transport processes in solids with different conduction mechanisms. Dielectric properties of solids. Mechanisms of dielectric polarization. Local and averaged macroscopic fields. Displacement currents. Dielectric losses. Thermodynamic properties of solids. Lattice vibrations. Concept of phonons. Heat capacity of solids. Einstein and Debye models. Magnetic properties of solids. Nature of magnetic phenomena in solids. Diamagnetism. Para- and ferromagnetism. Magnetic domains. Magnetic susceptibility and magnetization of solids. Hysteresis phenomena. Phase transitions in magnetic materials. Curie temperature. Optical properties of solids. Propagation of electromagnetic waves in solids. Light absorption and refraction. Optical constants. Recombination radiation. Stimulated emission. Lasers. Nanostructures and solid-state nanomaterials. Structure of nanostructured materials. Electrical properties of nanocrystals. Methods of obtaining nanocrystals.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of major types of solids, their structures and physical properties; scalar and vector fields and their applications to solid-state processes; the nature of electrical conductivity, polarization, magnetic and optical phenomena; Einstein and Debye models for heat capacity and lattice vibrations[1]
- **be able to a**pply vector and tensor analysis in solid-state problems; analyze band diagrams and interpret charge carrier behavior; calculate electrical, thermal, magnetic, and optical properties of materials based on physical models[2]
- **possess practical skills** in using physical models and equations describing solids; applying knowledge in engineering and research activities; interpreting experimental data from solid-state measurements (I–V characteristics, dielectric constant, spectra, etc.)[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Mechanics, Thermal Physics.

**Bibliography**


1. Ч. Киттель. “Введение в физику твердого тела”, М: Мир. 1978
2. Дж. Блэкмор. “Физика твердого тела”, М: 1998
3. П.В.Павлов, А.Ф. Хохлов. “ Физика твердого тела”. М.:Высшая Школа. 2000

4. Тешабоев А.Т., Зайнобидинов С., Эрматов Ш. Каттиқ жисм физикаси. Т.: «Молия», 2001.
5. Xidirov I. “Qattiq jism fizikasi”. O’quv qo’llanma. Toshkent: Mumtoz So’z. 2019.

Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 9-10 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** after completing approximately half of the material, students will receive written exam variants including 3 theoretical questions and 1 problem. Each correct answer is awarded up to 5 points.

**Final Assessment:** based on the entire course content, with exam variants including 3 theoretical questions and 1 problem. Students submit written answers, then defend them orally, receiving up to 5 points per answer. Final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| QK2704 | Kinetic Phenomena in Solids | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions | 30 h |
| Problem solving | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Yuldashev Shavkat; Associate Prof., Dr. Parchinskiy Pavel;

**Course content**

General information on semiconductor materials. Basic parameters of semiconductors. Non-equilibrium and equilibrium charge carriers. Fundamentals of band theory of semiconductors. Semiconductor conductivity. Mechanisms of electrical conduction in semiconductors. Diffusion and drift currents. Generation and recombination processes. Continuity equation. Einstein relation. Boltzmann transport equation. Scattering of charge carriers. Mobility. Dependence of mobility on temperature and electric field strength. Structure of the Boltzmann kinetic equation. Collision integral. Relaxation time. Galvanomagnetic phenomena. Hall effect. Magnetoresistance effect. Thermal conductivity of semiconductors. Thermoelectric phenomena: Seebeck effect, Peltier effect, Thomson effect. Thermomagnetic phenomena: Nernst–Ettingshausen effect, Righi–Leduc effect. Applications of kinetic phenomena. Everyday significance of kinetic phenomena. Scientific importance and areas of application of kinetic effects.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the main physical parameters of semiconductors and charge carriers; fundamentals of band theory and principles of conductivity in semiconductors; structure and physical meaning of the Boltzmann transport equation; principles of generation, recombination, and scattering of carriers; the concepts of scalar and vector fields and their application in solid-state kinetics[1]
- **be able to** apply vector and tensor analysis methods to model kinetic processes; analyze mobility and parameter dependencies on external conditions (temperature, electric/magnetic field); interpret galvanomagnetic, thermoelectric, and thermomagnetic phenomena using physical-mathematical models[2]
- **possess practical skills** in applying transport and kinetic equations; using knowledge of kinetic phenomena in engineering and research tasks in solid-state physics; evaluating the importance and applications of kinetic effects in modern technology and science[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Mechanics, Thermal Physics

**Bibliography**


1. Zaynobidinov S., Teshaboev A.T. Yarimo‘tkazgichlar fizikasi. T. «O‘qituvchi». 1999.
2. Teshaboev A., Zaynobiddinov S., Ermatov Sh. Qattiq jism fizikasi. T. «Moliya». 2001.
3. Mamatkarimov O.O., Vlasov S.I., Nazirov D.E. «Yarimo‘tkazgich materiallar va asboblar fizikasi praktikumi». T. O‘zMU. 2007.

4. Шалимова К.В. Физика полупроводников. М. 2010. (http://opac.mpei.ru/notices/index/IdNotice:170700/Source:default).
5. Фистуль В.И. Введение в физику полупроводников. М. Высшая школа. 1984.

Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 9-10 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** after completing approximately half of the material, students will receive written exam variants including 3 theoretical questions and 1 problem. Each correct answer is awarded up to 5 points.

**Final Assessment:** based on the entire course content, with exam variants including 3 theoretical questions and 1 problem. Students submit written answers, then defend them orally, receiving up to 5 points per answer. Final grade is calculated as the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| NA2704 | Fundamentals of Nanophysics | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions | 30 h |
| Problem solving | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Abdurakhmanov Gulmirza; Prof., Dr. Shoislomov Ulugbek

**Course content**

MBICS-technologies. Stages of development of nanotechnology and their physical foundations. Elements of solid-state physics. Nanomaterials: fullerenes, carbon nanotubes, and graphene, their physical properties. Fundamental electronic phenomena in nanostructures: quantum size effects, quantum confinement. Fundamental electronic phenomena in nanostructures II: two-dimensional (2D) electron system. Quantum well. Fundamental electronic phenomena in nanostructures III: band diagrams for different pairs of semiconductor materials. Inversion layers in silicon structures. Metal–dielectric–semiconductor (MDS/MOS) transistors. Heterostructures. Quantum Hall effects. Modulation doping. Composite nanoparticles. Fermions and bosons. Quantization of one-dimensional (1D) electron systems. Density of states. Ballistic transport. Coulomb blockade. Zero-dimensional (0D) electronic structures. Quantum dots. Density of states. Nanoparticles and their physical properties. Quantum tunneling effect I. Resonant tunneling. Single-electron transistor. Quantum tunneling effect II. Resonant tunneling. Single-electron transistor. Resonant-tunneling transistor based on a quantum dot. Surface plasmon resonance (SPR). Total internal reflection of light. Localized plasmon resonance. Applications of SPR. SPR diagnostics. Elements of nanophotonics. Photonic band gap. Photonic crystals.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the physical foundations of nanotechnology, including elements of quantum mechanics, solid-state physics, and band theory; stages of nanotechnology development and the concept of MBICS-technologies; types and properties of nanomaterials (fullerenes, nanotubes, graphene, quantum dots, nanoparticles, etc.); fundamental electronic phenomena in nanostructures (quantum size effects, tunneling, ballistic transport, Coulomb blockade); design and operation principles of nanoscale electronic and optoelectronic devices (MOSFETs, single-electron and resonant-tunneling transistors); fundamentals of nanophotonics, including photonic crystals, photonic band gaps, and plasmon resonances[1]
- **be able to** analyze physical processes in nanostructures using concepts of quantum mechanics, electrodynamics, and band theory; apply vector and tensor analysis methods to calculate electronic, thermal, and optical characteristics; interpret band diagrams and energy states in 0D, 1D, and 2D structures, identify carrier types and transport features; use modern physical and mathematical models for analyzing nanoscale devices[2]
- **possess practical skills** in analyzing and interpreting experimental data on nanostructure properties; calculating physical parameters of nanosystems using computer modeling and specialized software; applying acquired knowledge to solve problems in nanophysics, micro- and nanoelectronics, nanophotonics, and related technological fields[3]

[1] knowledge; [2] skills; [3] abilities;

| Teaching and learning methods |
|---|
| Lectures; Problem solving; Self-study; Group work; |
| **Admission requirements** |
| Mandatory: No<br>Recommended: Mechanics, Thermal Physics |
| **Bibliography** |
| 1. Вартанян Т.А. Основы физики металлических наноструктур. С.-Петербург: ИТМО, 2013.<br>2. Микро- и наномир материалов. Москва: Изд-во МГУ, 2006.<br>3. Андриевский Р.А., Рагуля А.В. Наноструктурные материалы. Москва: Academa, 2005.<br>4. Балоян Б.М., Колмаков А.Г., Алымов М.И., Кротов А.М. Наноматериалы. Классификация, свойства, применение и получение. Москва: УГРЕША, 2007.<br>5. Елисеев А.А., Лукашин А.В. Свойства наноразмерных материалов. Москва: МГУ, 2007 |
| **Assessments** |
| Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.<br><br>**Type of Assessment** — **CA** — **FA**<br>Timing — 9-10 th week — 19-20 th week<br>Form of Assessment — written exam — written and oral exam<br><br>**Continuous Assessment:** after completing approximately half of the material, written exam variants include 3 theoretical questions and 1 problem. Each correct answer is awarded up to 5 points.<br>**Final Assessment:** based on the entire course content, with exam variants including 3 theoretical questions and 1 problem. Students submit written answers, then answer orally, with a maximum of 5 points per response. Final grade is the arithmetic mean. |
| **Educational Materials and Media Tools** |
| Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials |

| NF2704 | Physics of Nanomaterials | | |
|---|---|---|---|
| | | | |
| Academic semester | 7 | ECTS | 4 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| Lectures | 30 h | Preparation for classroom sessions | 30 h |
| Problem solving | 30 h | Literary Studies | 30 h |
| Total | 60 h | Total | 60 h |
| Total work-load | 120 h | | |

**Lecturers**

Prof., Dr. Abdurakhmanov Gulmirza; Prof., Dr. Shoislomov Ulugbek

**Course content**

Specific features of physical interactions at the nanoscale. Micro- and nanofluidics: interfacial boundary, capillarity, and wetting. Structure and properties of the main types of nanomaterials. Influence of surface-to-volume ratio on the properties of nanosystems. Mechanical properties of nanosystems. Friction force. Coulomb force. Van der Waals forces. Optics of nanosystems. Micro- and nanofluidics: interfacial boundary, capillarity, and wetting. Structure and properties of the main types of nanomaterials. Structure of porous and nanodispersed systems. Morphological diversity of nanodispersed systems. Fundamental mechanisms of nanodispersed system formation. Composite nanomaterials. Composites: matrix and filler. Dispersed phases. Geometry of filler particles. Classification of composite materials. Basic methods of nanomaterial synthesis. Quantum size effects, quantum confinement. Two-dimensional (2D) electron system. Quantization in one-dimensional (1D) electronic systems. Quantum Hall effects. Quantum tunneling effect. Resonant tunneling. Single-electron transistor. Optical properties of nanomaterials. Surface plasmon resonance (SPR). Elements of nanophotonics. Photonic band gap. Photonic crystals.

**Learning objectives**

Upon successful completion of this course, students should:

- **possess knowledge and understanding** of the fundamental principles of nanoscale interactions; physical properties and classification of major types of nanomaterials and nanostructures; nature of quantum size effects and features of electronic states in 0D, 1D, and 2D systems; methods of synthesis and morphology of nanodispersed and composite systems; optical, electrical, and mechanical properties of nanomaterials; fundamentals of nanophotonics and phenomena such as surface plasmon resonance (SPR) and photonic crystals[1]
- **be able to** apply vector and tensor analysis to describe the physical properties of nanomaterials; analyze the influence of size effects on macroscopic material properties; evaluate the behavior of nanosystems in various physical fields (electric, magnetic, optical); apply acquired knowledge to calculate characteristics of nanostructures and their interactions with radiation[2]
- **possess practical skills** in modeling physical processes in nanostructures; processing and interpreting data on nanomaterial properties; applying acquired knowledge in practical and research tasks in nanophysics and nanotechnology[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Lectures; Problem solving; Self-study; Group work;

**Admission requirements**

Mandatory: No
Recommended: Mechanics, Thermal Physics

Bibliography


1. Вартанян Т.А. Основы физики металлических наноструктур. - С.-Петербург: ИТМО, 2013.
2. Ryndyk D.A. Theory of Quantum Transport at Nanoscale. An Introduction. –New York: Springer, 2016.
3. Nouailhat A. An Introduction to Nanoscience and Nanotechnology. – Hoboken: Wiley, 2008.
4. Trügler A. Optical Properties of Metallic Nanoparticles. Basic Principles and Simulation. – New York: Springer, 2016.


Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **CA** | **FA** |
|---|---|---|
| Timing | 9-10 th week | 19-20 th week |
| Form of Assessment | written exam | written and oral exam |

**Continuous Assessment:** after completing approximately half of the material, written exam variants include 3 theoretical questions and 1 problem. Each correct answer is awarded up to 5 points.

**Final Assessment:** based on the entire course content, with exam variants including 3 theoretical questions and 1 problem. Students submit written answers, then answer orally, with a maximum of 5 points per response. Final grade is the arithmetic mean.

Educational Materials and Media Tools

Projector; white/black board; printed handouts; visual aids for presentations; demonstration equipment and materials

| FFAB119.1 | Qualification Internship I (Orientation Internship) | | |
|---|---|---|---|
| | | | |
| Academic semester | 4 | ECTS | 2 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| | | Orientation Internship for 2nd-Year Students of the Physics Education Program | 30 h |
| Total work-load | 30 h | | |

**Lecturers**

Associate Prof. Dr. Begmatova Dilfuza; Prof., Dr. Kurvanov Mirzaakhmat

**Course content**

Developing skills and competencies in creating and applying demonstration experiments related to *Electricity* and *Optics*. Preparing to conduct laboratory works in these sections, including reviewing relevant literature and theoretical concepts, and becoming familiar with instruments and devices. Performing measurements or identifying physical phenomena related to the given task using appropriate instruments. Recording measured and calculated quantities and their uncertainties; plotting graphical relationships on graph paper where necessary. Reviewing the physical processes studied in the laboratory work, analyzing the strengths and weaknesses of the experimental method used, and providing suggestions for its improvement. Assembling and analyzing electrical circuits related to radio engineering. Getting acquainted with the research directions of the branch institutes of the Academy of Sciences of the Republic of Uzbekistan and preparing a summary report on the scientific research being conducted there. After completing each specific topic, the results are discussed in detail under the supervision of the instructor, followed by an assessment (test or evaluation). All outcomes of the internship are summarized in a written report.

**Laboratory Experiments in General Physics**

"Electricity" Section: Study of Ohm's Law for alternating currents; Investigation of the laws of charging and discharging of a capacitor; Measurement of the Earth's magnetic field using a rotating induction coil; Study of the volt-ampere characteristic (VAC) of a vacuum diode.

"Optics" Section: Determination of the refractive index and dispersion of liquids; Investigation of the absorption spectrum in colored liquids;Study of the phenomenon of dispersion at several wavelengths; Determination of the wavelength of a helium–neon laser using a Michelson interferometer.

"Electronics and Signal Processing" Section: Transistors. Electronic switch; Semiconductors. Diode. Study of the operation of a light-emitting diode (LED);Generators. Multivibrator.

**Learning objectives**

Upon successful completion of this course, students should:

- Know the fundamental principles and laws of general physics, particularly in *electricity*, *optics*, and *radioelectronics*; Understand the physical basis and theoretical background of laboratory and demonstration experiments; Have knowledge of the structure, operation, and application of basic laboratory instruments and measuring devices; Be familiar with research areas and activities of the branch institutes of the Academy of Sciences of the Republic of Uzbekistan[1]
- Independently perform laboratory and demonstration experiments related to electricity, optics, and electronics; Apply experimental methods for measuring physical quantities and calculating uncertainties; Correctly operate laboratory equipment and set up electrical circuits; Record, process, and graphically present experimental data; Analyze and interpret experimental results and identify measurement errors; Prepare a written report summarizing the experimental work and its outcomes.[2]

- Integrate theoretical and experimental knowledge in solving physical problems; Work effectively both independently and in a team in laboratory and research environments; Show responsibility, accuracy, and adherence to safety regulations during experiments; Communicate experimental results clearly in oral and written form; Engage in analytical thinking and continuous self-improvement in experimental physics.[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Laboratory work; Self-study; Group work;

Admission requirements

Mandatory: Thermal Physics; Optics; Electisity
Recommended: Mechanics

Bibliography


1. Tursunmetov K.A. Turg‘unboev F.Yu. Xamidjonov I.X. Umumiy fizika kursidan praktikum “Mexanika” O‘quv qO‘llanma T.:-2019 y.
2. Tursunmetov K.A. Umumiy fizika. Mexanikadan laboratoriya ishlari. O‘zMU, 2021y.
3. Турсунметов К.А., Далиев Х.С. Механика 1-қисм. Тошкент., Университет 2000 й.
4. Назиров Э.Н. ва бошқалар. Механика ва молекуляр физикадан практикум. Ўзбекистон, Т.-2001й
5. Турсунметов К.А. ва бошқалар. Умумий физика курсидан практикум. Механика. Университет. Т.-1998й.
6. Ландсберг Г.С. "Оптика" Т 1981.
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10. Polvonov S.R., Sh.M. Ruzimov, M.I. Mamajusupova. Atom va yadro fizikasidan laboratoriya ishlari. T. “UNIVERSITET”, 2020. – 120 b.
11. Каноков З., Караходжаев А.К., Насриддинов К.Р., Полвнов С.Р. Атом ва ядро физикасидан лаборатория ишлари. Университет. Т.-2002.-148 б.
12. Бояркина А.Н., Гончарова Н.Г. и др. Практикум по ядерной физике. М.: Изд-во Московского ун-та, 1988. – 199 с.
13. Polvonov S.R., Kanokov Z., Ruzimov Sh.M. Atom va yadro fizikasidan masalalar to‘plami. T. “UNIVERSITET”, 2017. – 200 b.


Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **FA** |
|---|---|
| Timing | 39-40 th week |
| Form of Assessment | Written report and oral exam |

**Final Assessment:** To successfully complete the orientation internship, students are required to submit a written report and provide oral answers to the supervisor’s control questions.

Educational Materials and Media Tools

Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| FFAB119.2 | Qualification Internship II (Professional Internship) | | |
|---|---|---|---|
| | | | |
| Academic semester | 6 | ECTS | 2 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| | | Professional Internship for 3rd-Year Students of the Physics Education Program | 30 h |
| Total work-load | 30 h | | |

**Lecturers**

Associate Prof. Dr. Begmatova Dilfuza; Prof., Dr. Kurvanov Mirzaakhmat

**Course content**

**Session 1.** Introduction of students to the regulations of the internship program at the Faculty of Physics. Familiarization with the scientific research areas and laboratories of the department, and distribution of students among laboratories according to their interests. In studying the history of the department, students become acquainted with the scientific research conducted by leading physicists of Uzbekistan. Participation in ongoing research activities of the department, and learning to collect samples for analysis.

**Session 2.** Introduction to the instruments and equipment used in research institute laboratories and to various analytical methods. Study of physical and physico-chemical analysis techniques, as well as familiarization with the instruments required for conducting such analyses.

**Session 3.** Study of the characteristics of laboratories that serve as research objects within scientific institutes. Learning about the fields of application and operational principles of physical research methods.

**Session 6.** Providing students with theoretical knowledge about various laboratory methods used in scientific research institutes.

**Session 7.** Organization and systematization of the collected data and materials, and preparation of reports. During the industrial internship, results are analyzed and systematized; all diagrams and graphs are prepared before starting to write the report. The report must include the following: 1) daily logbook, 2) internship report.

**Learning objectives**

Upon successful completion of this course, students should:

- know the structure, regulations, and research directions of the Department of Physics and related research institutes; the historical development of the department and the scientific contributions of leading physicists in Uzbekistan; the fundamental laws and principles of physics, including mechanics, Thermal Physics and thermodynamics, electricity and electromagnetism, optics, atomic and nuclear physics; the principles and applications of physical and physico-chemical analysis methods used in modern laboratories; the role of physics in scientific and technological research and its connection to real-world natural phenomena[1]
- correctly interpret and explain the nature of physical phenomena using general physical laws; apply theoretical knowledge of physics to practical and experimental situations; operate standard physical measuring instruments and laboratory equipment safely and effectively; conduct experimental work, including data collection, analysis, and presentation of results; use analytical and graphical methods to process and interpret experimental data; prepare structured and well-documented internship reports summarizing obtained results[2]
- integrate scientific knowledge with practical applications in physics and related technologies; participate independently in research projects and contribute to laboratory

investigations; critically analyze physical processes and experimental outcomes; work collaboratively within research teams and communicate scientific results effectively; exhibit professional responsibility, accuracy, and adherence to scientific and ethical standards in research and reporting; continue independent learning and professional development in the field of physics[3].

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Laboratory work; Self-study; Group work;

Admission requirements

Mandatory: Mechanics; Thermal Physics; Optics; Electisity; Atomic Physics Nuclear and Elementary Particles Physics

Recommended: All other subjects in Physics

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Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **FA** |
|---|---|
| Timing | 39-40 th week |
| Form of Assessment | Written report and oral exam |

**Final Assessment:** Each student must prepare an individual report. During the report evaluation, the knowledge, professional skills, and competencies acquired by each student during the internship are assessed.

Educational Materials and Media Tools

Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| FFAB119.3 | Qualification Internship III (Teaching internship) | | |
|---|---|---|---|
| | | | |
| Academic semester | 8 | ECTS | 8 |
| | | | |
| Academic workload | | | |
| Contact hours | | Independent work | |
| | | Teaching internship for 4th-Year Students of the Physics Education Program | 120 h |
| Total work-load | 120 h | | |
| Lecturers | | | |
| Associate Prof. Dr. Begmatova Dilfuza; Prof., Dr. Kurvanov Mirzaakhmat | | | |
| Course content | | | |

1. Orientation Phase (1 week)

**Meeting with school and academic lyceum administration:** Conversation between the internship students and the school or academic lyceum leadership (deputy principal for academic affairs). Familiarization with the official documents of the school and academic lyceum, the general plans of the principal and physics teachers (time should be specified).

**Distribution of students by classes and groups:** Assignment of students to specific classes and groups; familiarization with the class and group supervisors and their work plans. Preparation of individual calendar plans for students' educational and instructional activities.

**Passive observation phase:** Attendance of physics and other subject lessons conducted by teachers; observation and analysis of their teaching methods and lesson structures.

**Study of teaching methods and resources:** Examination of the scientific and theoretical level and pedagogical mastery of physics teachers, as well as their use of additional literature, instructional materials, technical teaching aids, and demonstration experiments.

**Preparation of the general plan of the pedagogical internship:** Development of a comprehensive internship plan for students at the assigned schools and academic lyceums.

II. Active Phase (7 weeks)

**Lesson schedule and distribution methods:** Preparation of a timetable for active teaching practice; methods for assigning classes and lessons; procedures for peer reviewing and preparing analytical reports. Determination of the number of lessons conducted by each trainee (maximum and minimum), and analysis of the trial and observed lessons.

**Teaching load and analysis by group:** Summary of the total number of teaching hours conducted by the trainees in schools and academic lyceums (separately for Uzbek- and Russian-language groups), along with a class-by-class analysis.

**Evaluation of lesson quality:** Analysis of the scientific and theoretical level of trainee lessons, including their use of supplementary literature, methodological materials, technical teaching aids, and physics demonstration experiments.

**Study of students' attitudes toward physics:** Investigation of the attitudes of school and academic lyceum students toward the subject of physics, as well as their perception of lessons conducted by trainee teachers.

**Monitoring and assessment of trainee performance:** a) Evaluation of trainees who delivered lessons of a high scientific and theoretical level; b) Evaluation of trainees who conducted lessons of insufficient quality; c) Analysis of those who demonstrated indifference toward their teaching duties despite having potential; d) Encouragement and recognition of active students who contributed effectively to organizing the educational process in schools and academic lyceums.

III. Extracurricular Activities

- Decorating the physics classrooms of schools and academic lyceums (detailed information on exhibits, posters, wall newspapers, albums, their quantity, titles, and the students responsible for them).
- Preparing physical instruments and laboratory equipment for lessons.
- Repairing and adjusting physical instruments and laboratory devices.
- Creating wall newspapers, photo collages, and organizing classroom bulletin boards, etc.
- Developing instructional and methodological materials.
- Organizing excursions and field trips (including separate visits to the Faculty of Physics of the National University of Uzbekistan).
- Working with underachieving students; conducting sessions with interesting questions, answers, and problem-solving activities.
- Conducting educational (advisory) class hours in classrooms or groups.
- Working with class or group leaders and student activists.
- Guiding students in career orientation through excursions, discussions, and other activities.
- Visiting students' homes.
- Participating in parent–teacher meetings.
- Organizing meetings between students and prominent scientists (physicists and others).
- Holding evening events dedicated to significant dates and occasions.
- Compiling a list of active students who made significant contributions to organizing educational and extracurricular activities at schools and academic lyceums.

IV. Final Phase (1 week)

- Conducting a final conference on teaching practice with the participation of trainee students, school and academic lyceum teachers, and administration.
- Compiling a general list of trainee students with their final evaluation grades.
- Preparing a list of students who failed to complete the internship program or received unsatisfactory evaluations.
- Preparing a list of students who violated the internal regulations of the schools or academic lyceums.
- Compiling a list of active students who made significant contributions to both educational and extracurricular work at schools and academic lyceums (for recognition by the university and faculty administration).
- Identifying and summarizing the main difficulties that hindered the successful completion of the internship (e.g., insufficient preparation of trainees, lack of methodological support from physics teachers, insufficient number of physics classrooms, etc.).
- Developing recommendations and proposals regarding the improvement of pedagogical practice for the following academic year.

Learning objectives

Upon successful completion of this course, students should:

- understand the principles and methods of teaching physics in secondary schools and academic lyceums; know of lesson planning, curriculum design, and assessment methods in physics education; awareness of modern pedagogical concepts, advanced teaching technologies, and information and communication technologies (ICT) in education; know of organizing and conducting spiritual-enlightenment and educational activities in the school environment; understanding of the responsibilities and documentation of a class

(group) leader, including the preparation of semester and annual teaching plans and journals[1]

- ability to prepare and deliver physics lessons using appropriate teaching methods and educational technologies; skill in assessing students' knowledge, skills, and competencies through various forms of evaluation; ability to analyze and reflect on lessons conducted by experienced teachers and peers to improve personal teaching performance; competence in designing and implementing lesson plans and teaching materials that align with curriculum goals; skill in integrating digital and information technologies into the educational process to enhance learning outcomes[2]
- abile to apply pedagogical and communication skills effectively in classroom and group management; capacity to independently organize and conduct high-quality physics lessons and extracurricular educational activities; readiness to adopt innovative teaching methods and continuously improve professional competence; collaborate with colleagues, students, and school administration in achieving educational objectives; be responsibility and initiative in fulfilling professional duties during pedagogical practice, demonstrating ethical and reflective teaching behavior[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Self-study; Group work;

Admission requirements

**Requirements for Students' Knowledge and Competence during the Pedagogical Practice.**

During the pedagogical practice, students are expected to demonstrate knowledge and competence in the following areas:

**Lesson preparation and delivery:** ability to prepare for lessons, present educational topics clearly, and assess students' knowledge, skills, and performance;

**Conducting various types of lessons:** ability to organize and conduct different lesson formats while developing professional knowledge, skills, and teaching competencies relevant to their specialization;

**Organizing educational and moral–spiritual activities:** ability to plan and conduct extracurricular and educational events that promote students' personal and moral development;

**Implementation of modern pedagogical technologies:** competence in integrating innovative teaching methods and educational technologies into the learning process;

**Lesson observation and analysis:** ability to attend and critically analyze lessons delivered by school and academic lyceum teachers—especially physics teachers—and fellow trainees;

**Use of information technologies in education:** proficiency in applying digital and information tools to enhance teaching and learning;

**Class management:** ability to perform the duties of a class (group) supervisor, including maintaining class journals and student records;

**Curriculum and planning:** ability to develop semester and annual teaching plans in physics;

**Lesson planning documentation:** ability to design and prepare detailed lesson plan outlines (lesson plan–conspectus).

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Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the

system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **FA** |
|---|---|
| Timing | 28-29 th week |
| Form of Assessment | Written report and oral exam |

**Final Assessment Criteria:**
**Grade "5" (Excellent)** – The student has successfully completed all the tasks specified in the program at the required level. Their knowledge, skills, and teaching methodology fully meet the established standards. The lesson plan notebook is complete and accurate. The student is also able to organize and conduct educational and spiritual-enlightenment activities; implement advanced pedagogical technologies in the learning process; analyze lessons conducted by physics teachers and peers; use information technologies in education; work as a group leader and maintain group journals; prepare semester and annual teaching plans in physics; prepare detailed lesson plans, and conduct independent lessons at a high professional level.
**Grade "4" (Good)** – The student has correctly completed all assigned tasks with one or two significant methodological errors. The student is able to organize and conduct educational and spiritual-enlightenment activities; implement advanced pedagogical technologies in the learning process; analyze lessons of physics teachers and peers; use information technologies in education; work as a group leader and maintain group journals; prepare semester and annual physics teaching plans; prepare lesson plans, and independently conduct lessons.
**Grade "3" (Satisfactory)** – The student has correctly completed about two-thirds of the assigned work or, in the case of completing all assignments, has made no more than one or two errors or up to four minor shortcomings. The student is able to organize and conduct educational and spiritual-enlightenment activities; apply advanced pedagogical technologies in the learning process; analyze lessons of physics teachers and peers; use information technologies in education; work as a group leader and maintain group journals; prepare lesson plans and conduct classes independently.
**Grade "2" (Unsatisfactory)** – The student is unable to organize and conduct educational and spiritual-enlightenment activities; fails to apply advanced pedagogical technologies in the learning process; cannot analyze lessons of physics teachers and peers; cannot work as a group leader or maintain group journals; fails to prepare lesson plans; and has excessive absences during the practice period.

Educational Materials and Media Tools

White/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| FFAB119.4 | Qualification Internship IV (Pre-graduation internship) | | |
|---|---|---|---|
| | | | |
| Academic semester | 8 | ECTS | 7 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| | | Professional Internship for 4th Year Students of the Physics Education Program | 30 h |
| Total work-load | 30 h | | |

**Lecturers**

Associate Prof. Dr. Begmatova Dilfuza; Prof., Dr. Kurvanov Mirzaakhmat

**Course content**

The pre-graduation internship of university students represents a consistent continuation of the educational process conducted at higher education institutions. It provides an opportunity for students to collect materials related to the topics of their bachelor's thesis, analyze relevant literature, and consolidate theoretical knowledge and research methods acquired during their studies within the chosen department. The internship also contributes to the development of professional competencies and practical skills.

During this internship, students expand and deepen the knowledge gained in their bachelor's program, strengthen and improve their academic and professional skills.

**The main tasks of the pre-graduation internship include:**

• Developing professional competencies and practical skills related to the topic of the bachelor's thesis.

• Strengthening theoretical understanding by studying literature and research methods relevant to the chosen topic, as well as acquiring knowledge about the necessary instruments and equipment.

• Analyzing the physical process related to the bachelor's thesis topic and providing suggestions for its improvement.

After completing the assigned work, the student discusses the results in detail under the supervision of the academic advisor and takes a final assessment. The outcomes of the internship are presented in a written report. The topics of bachelor's theses are determined by each department according to their specialization and are assigned to students by the internship supervisor.

**Learning objectives**

- Understand the fundamental physical laws, principles, and processes related to the chosen topic of the bachelor's thesis; Demonstrate knowledge of the key theoretical concepts and literature relevant to the selected research area; Know the meaning, units, and relationships of measurable physical quantities; Be familiar with experimental instruments, devices, and measurement methods relevant to the topic; Understand the structure, methodology, and ethical principles of scientific research and reporting.[1]
- Apply theoretical knowledge to analyze and interpret physical phenomena and processes related to the thesis topic; Use computational formulas correctly in problem-solving and data processing; Select and employ appropriate research methods and technical tools for data collection and analysis; Work independently on the bachelor's thesis, preparing a coherent and scientifically grounded written report; Use modern information technologies for data processing, visualization, and documentation.[2]
- Independently plan, conduct, and complete a small-scale scientific or applied research project in physics; Critically evaluate results, identify sources of error, and propose

improvements or refinements; Present and justify research findings both in written and oral forms using scientific argumentation; Integrate theoretical and experimental knowledge for solving specific physical problems; Demonstrate responsibility, initiative, and professional ethics during the research and reporting process.[3]

[1] knowledge; [2] skills; [3] abilities;

Teaching and learning methods

Laboratory work; Self-study; Group work;

Admission requirements

Mandatory: Mechanics; Thermal Physics; Optics; Electisity; Atomic Physics Nuclear and Elementary Particles Physics
Recommended: All other subjects in Physics

Bibliography

Recommended by the internship supervisor based on the chosen field of specialization.

Assessments

Assessment of students' knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students' knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **FA** |
|---|---|
| Timing | 36-38 th week |
| Form of Assessment | Written report and oral exam |

**Final Assessment Criteria:**

**Grade "3"**

The student knows the main laws, principles, and processes related to the chosen topic.
They can correctly write and explain the fundamental formulas, understand the subject of the bachelor's thesis, and describe it accurately.
The student knows the meaning and units of measurable quantities and can describe the computational formulas correctly, though without proof.

**Grade "4"** –

The student knows the main laws, principles, and processes related to the chosen topic.
They can correctly write and explain the fundamental formulas, understand and describe the topic of the bachelor's thesis appropriately, and know the meaning and units of measurable quantities.
The student can correctly describe the computational formulas (without proof), perform the thesis work independently, and analyze the obtained results.

**Grade "5"** –

The student knows the main laws, principles, and processes related to the chosen topic.
They can correctly write and explain the fundamental formulas and apply them to derive the relevant physical parameters.
They understand and can describe the topic of the bachelor's thesis, know the meaning and units of measurable quantities, and can describe the computational formulas correctly (without proof).
The student can independently complete the bachelor's thesis, analyze the results, and scientifically justify both the theoretical and practical parts of the report with independent reasoning.
They are able to provide a correct and comprehensive theoretical description of the topics related to their bachelor's thesis.

Educational Materials and Media Tools

Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials

| YDAB415 | Final State Attestation (Including Defense of the Bachelor Thesis) | | |
|---|---|---|---|
| | | | |
| Academic semester | 8 | ECTS | 15 |

| Academic workload | | | |
|---|---|---|---|
| Contact hours | | Independent work | |
| | | Professional Internship for 4th Year Students of the Physics Education Program | 90 h |
| Total work-load | 90 h | | |

**Lecturers**

Prof. Dr. Musakhanov Mirzayusuf; Associate Prof. Dr. Begmatova Dilfuza; Associate Prof., Dr. Nasirov Abdumannop; Associate Prof. Dr. Akhmadjanov Turgunali; Prof. Polvonov Sotimboy

**Course content**

**Mechanics:** Kinematics, Dynamics, Work and Energy, Friction Forces, Motion of a Body in a Non-inertial Reference Frame, Rotational Motion of Rigid Bodies, Deformation, Law of Universal Gravitation, Motion of Liquids and Gases, Oscillatory Motion, Waves.
**Electricity and Magnetism:** Electrostatics, Direct Electric Current, Nature of Electrical Conductivity, Magnetic Field of Electric Currents, Magnetism, Electric Oscillations and Waves.
**Optics:** Electromagnetic Nature of Light Phenomena, Propagation, Refraction and Reflection of Electromagnetic Waves, Interference of Light, Diffraction of Light, Polarization of Light and Crystal Optics, Thermal Radiation, Scattering of Light, Corpuscular Properties of Light, Optics of Moving Media.
**Atomic Physics:** Thermal Radiation, Corpuscular Properties of Electromagnetic Radiation, Bohr Theory of the Hydrogen Atom, Particles and Waves, Fundamentals of Quantum Mechanics, Single-electron Atoms, Multi-electron Atoms, Atoms in External Fields, Molecules.

**Learning objectives**

- Understand the fundamental physical laws, principles, and processes related to the chosen topic of the bachelor's thesis; Demonstrate knowledge of the key theoretical concepts and literature relevant to the selected research area; Know the meaning, units, and relationships of measurable physical quantities; Be familiar with experimental instruments, devices, and measurement methods relevant to the topic; Understand the structure, methodology, and ethical principles of scientific research and reporting.[1]
- Apply theoretical knowledge to analyze and interpret physical phenomena and processes related to the thesis topic; Use computational formulas correctly in problem-solving and data processing; Select and employ appropriate research methods and technical tools for data collection and analysis; Work independently on the bachelor's thesis, preparing a coherent and scientifically grounded written report; Use modern information technologies for data processing, visualization, and documentation.[2]
- Independently plan, conduct, and complete a small-scale scientific or applied research project in physics; Critically evaluate results, identify sources of error, and propose improvements or refinements; Present and justify research findings both in written and oral forms using scientific argumentation; Integrate theoretical and experimental knowledge for solving specific physical problems; Demonstrate responsibility, initiative, and professional ethics during the research and reporting process.[3]

[1] knowledge; [2] skills; [3] abilities;

**Teaching and learning methods**

Laboratory work; Self-study; Group work;

Admission requirements

Mandatory: Mechanics; Optics; Electisity and Magnetizm; Atomic Physics
Recommended: All other subjects in Physics

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Assessments

Assessment of students’ knowledge is carried out in accordance with the Regulation on the system for monitoring and assessing students’ knowledge in higher education institutions developed based on the credit-module system.

| **Type of Assessment** | **FA** |
|---|---|
| Timing | 36-38 th week |
| Form of Assessment | Written report and oral exam |

The State Attestation is conducted in written form and is assessed according to a five-point grading system. Each student is given a test paper consisting of four questions, and each answer is evaluated with a maximum score of five points. The final grade is determined as the average of the scores obtained for the individual questions. Students’ written work is evaluated based on the following assessment criteria:

**Grade “5”** –

- the student is able to draw independent conclusions and make decisions;
- demonstrates creative thinking;
- shows independent judgment;
- can apply the acquired knowledge in practice;
- understands the essence of the discipline (topic);
- possesses solid knowledge of the subject;
- can clearly express and explain the content;
- demonstrates a comprehensive understanding of the discipline (topic).

**Grade “4”** –

- the student shows independent judgment;
- can apply the acquired knowledge in practice;
- understands the essence of the discipline (topic);

- possesses sufficient knowledge of the subject;
- can express and explain the content;
- demonstrates understanding of the discipline (topic).

**Grade "3"**

- the student can apply the acquired knowledge in practice;
- understands the main idea of the discipline (topic);
- possesses basic knowledge of the subject;
- can express and explain the content;
- demonstrates partial understanding of the discipline (topic).

**Grade "2"**

- the student has not mastered the course program;
- does not understand the essence of the discipline (topic) and demonstrates no understanding of the subject matter.

| Educational Materials and Media Tools |
| --- |
| Laboratory setups; white/black board; printed handouts; measuring instruments and equipment; demonstration equipment and materials |