**Al-Farabi Kazakh National University**
**Faculty of Physics and Technology**
**Chair of Theoretical and Nuclear Physics**

# Syllabus
**Spring semester, 2017-2018academicyear**

## Academic course information

| Discipline's code | Discipline's title | Type | No. of hours per week | | | Number of credits | ECTS |
|---|---|---|---|---|---|---|---|
| | | | Lect. | Pract. | Lab. | | |
| **IGTF 3302** | Selected chapters of the theoretical physics | Elective | 2 | 1 | 0 | 3 | 5 |

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| Lecturer | TakibayevN.Zh., d.s.p.-m., academic of NAS RK, professor | Office hours | Scheduled |
| e-mail | E-mail: takibayev@gmail.com | | |
| Telephone number | Telephone: *2925-133; 8-777-704-0396* | Auditory | 319 |

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|---|---|
| Academic presentation of the course | **Typeofcourse** (theoretical, practical; basic, elective) and its purpose (role and place of the course in the educational program): Theoretical Nuclear Physics.<br>**The aim of the course:** to give the students the deep understanding of themodern physics of nucleus of atoms and quantum mechanics of many-particle systems and self study, to form a system of competences in the context of qualification requirements:∗<br>A) be able to –demonstrate acquired knowledge (specifically) and it's understanding; - demonstrate an understanding of the over all structure of the study field and the relations between its elements (specifically);<br>B) be able to – include new knowledge in the context of basic knowledge, interpret its contents; - analyze educational situation and offer direction to solve it; - use methods (research, calculation, analysis, etc.) inherent to the field of study (specifically) individually or in a group teaching and research activities;<br>C) be able to - synthesize, interpret and evaluate the learning out comes of discipline, modules, midterm exam content (specifically);<br>D) be able to – constructive educational and social interaction and cooperation in the group; - propose to consider a problem, to reason its importance; - accept criticism and to criticize; - work in a team;<br>E) be able to – recognize the role of taken course in the implementation of individual learning paths. ∗The system of descriptor verbs must be used during the formation of competences (Look in Application 2) ∗∗Active and interactive methods is recommended to ensure deeper understanding and learning of educational material and to achieve learning out comes of the course (individual researches, group projects, case studies and there methods). |
| Prerequisites | Mathematical analysis, the theory of functions of complex variables, differentialequations, mathematical physics, statistical physics, physics of elementaryparticles. |
| Post requisites | The theory of gauge fields and electroweak interactions, chromodynamics, quantum gravity. |

<table>
<tr><td>Information resources</td><td>Literature (with an indication of the authors and data output), the availability(number), software and consumables with information about where you can get them. (8-9)<br>Recommended:<br>1. Masud Chaichian, Hugo Prez Rojas, Anca Tureanu, Basic Concepts in Physics, Springer Heidelberg New York Dordrecht London, 2014, ISBN 978-3-642-19597-6 2.<br>2. G.H.Wannier, Statistical Physics, Dover, New York, 1987.<br>3. L.D. Landau, E.M. Lifshitz, Statistical Physics, 3rd edn. Pergamon, London, 1981.<br>4. R.P. Feynman, The Feynman Lectures on Physics, Addison Wesley, Massachusetts, 1969.<br>5. M. Chaichian, I. Merches, A. Tureanu, Electrodynamics, Springer, Berlin Heidelberg, 2014.<br>6. F. Mandl, G. Shaw, Quantum Field Theory, Wiley, London, 2010.<br>7. L.D. Landau, E.M. Lifshitz, Quantum mechanics, 3rd edn. Pergamon, London, 1989, p. 768.<br>8. L. B. Okun: Leptons and quarks, translated from Russian by V. I. Kisin, North-Holland, 1982.<br>Additional:<br>1. R.K. Pathria, Statistical Mechanics, 2nd edn., Elsevier, Oxford, 2006.<br>2. C. Kittel, Solid State Physics, 8th edn., Wiley, New York, 2005.<br>3. F. Halzen, A. Martin, Quarks and leptons: An Introductory Course in Modern Particle Physics. USA, 1984.<br>4. M. Chaichian, A. Demichev, Path Integrals in Physics. Vol. 1: Stochastic processes andquantum mechanics, IOP, Bristol, UK, 2001.<br>5. M.A. Nielsen, I.L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, Cambridge, 2010.<br>6. I.D. Lawrie, A Unified Grand Tour of Theoretical Physics, IOP, Bristol, 2002.</td></tr>
<tr><td>Academic policy of the course in the context of university moral and ethical values</td><td>Academic Behavior Rules:<br>Compulsory attendance in the classroom, the impermissibility of late attendance. Without advance notice of absence and undue tardiness to the teacher is estimated at 0 points.<br>Academic values:<br>Inadmissibility of plagiarism, forgery, cheating at all stages of the knowledge control, and disrespectful attitude towards teachers. (The code of KazNU Student’s honor)</td></tr>
<tr><td>Evaluation and attestation policy</td><td>Criteria-based evaluation:<br>Assessment of learning outcomes in correlation withdescriptors (verification of competence formation during midterm control andexaminations).<br>Summative evaluation:<br>evaluation of the presence and activity of the work in the classroom; assessment of the assignment, independent work of students.<br>The formula for calculating the final grade.<br>$$\text{Final grade for the discipline} = \frac{\text{IC1} + \text{IC2}}{2} \cdot 0{,}6 + 0{,}1\text{MT} + 0{,}3\text{FC}$$<br>Below are the minimum estimates in percentage terms:<br>5% - 100%: A 90% - 94%: A-<br>85% - 89%: B+ 80% - 84%: B 75% - 79%: B-<br>70% - 74%: C+ 65% - 69%: C 60% - 64%: C-<br>55% - 59%: D+ 50% - 54%: D- 0% -49%: F</td></tr>
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Calendar (schedule) the implementation of the course content**:**

| **Weeks** | Topic title (lectures, practical classes, Independent work of students) | Number of hours | Maximum score |
|---|---|---|---|
| | **Module 1** | | |
| **1** | Lecture-1 (L-1). Laws of Thermodynamics, Thermodynamic Potentials. | **2** | - |
| | Seminar -1 (S-1). Operators and inverse operators, the uncertainty principle and the principle of superposition, matrices. | **1** | *5* |
| **2** | L-2. Schrödinger equation, flux density, linear oscillator, potential box, the transmission coefficient. | **2** | - |
| | S-2. Energy and momentum, transformation matrices, matrix density. | **1** | *5* |
| **3** | L-3. Angular momentum, eigen values and eigen functions, parity states. | **2** | - |
| | S-3. Motion in a centrally symmetric field. Spherical coordinates, decomposition in plane waves. | **1** | 5 |
| | SSWT 1.Prepare the report: Motion in a centrally symmetric field. Spherical coordinates, decomposition in plane waves. | **1** | 20 |
| **4** | L-4. Electrostatic and Gravitational Fields. Conductors, Semiconductors, Isolators. | **2** | - |
| | S-4. Gauss's Law for Electric Fields. Gauss's Law for Magnetism. | **1** | *5* |
| | **Module 2** | | |
| **5** | L-5. Maxwell's Equations, Lorentz Force. | **2** | - |
| | S-5. Fields in a Medium. | **1** | 5 |
| | SSWT 2. Prepare the report: Fields in a Medium. | **1** | 20 |
| **6** | L.-6. Magnetic Properties. Diamagnetism, Paramagnetism and Ferromagnetism. | **2** | - |
| | S.-6. Phase Transitions, Spontaneous Symmetry Breaking. | **1** | 5 |
| **7** | L.-7. Black Body Radiation. Dispersion of Light. | **2** | - |
| | S.-7. Reflection and Refraction. | **1** | 5 |
| | SSWT 3. Prepare the report: Reflection and Refraction. | **1** | 25 |
| | **1stIntermediate Control (IC1)** | | **100** |
| **8** | **Midterm (MT)** | | **100** |
| **8** | L-8. Wave Function. Operators and States in Quantum Mechanics. | **2** | - |
| | S-8. Harmonic Oscillator. Ladder Operators. | **1** | 5 |
| | **Module 3** | | |
| **9** | L-9. Emission and Absorption of Radiation. Tunnel. | **2** | - |
| | S-9. Exchange Interaction. Exchange Energy and Ferromagnetism. | **1** | 5 |
| | SSWT 4. Prepare the report: Paradoxes in Quantum Mechanics. Schrodinger Cat. EPR Einstein, Podolsky, Rosen Paradox. | **1** | 10 |
| **10** | L-10. Quantized Fields and Particles. Dirac Equation. | **2** | - |
| | S-10**.** Natural Units and the Metric Used in Particle Physics. | **1** | 5 |
| **11** | L-11. Quantum Electrodynamics. Unitarity. Feynman Diagrams. | **2** | - |
| | S-11. Real and Virtual Particles in Feynman Diagrams | **1** | 5 |
| | SSWT 5. Prepare the report: Compton Scattering, the | **1** | 10 |

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| | formation of electron-positron pairs. | | |
| **12** | L-12. Quantum Vacuum and Casimir Effect. Principle of Gauge Invariance. CPT Symmetry. | **2** | - |
| | S-12. Electron Self-energy. Vacuum Polarization. | **1** | 5 |
| **13** | L-13. Theory of Weak Interactions, YangMills Fields, Nambu-Goldstone Theorem. | **2** | - |
| | S-13**.** Electroweak Phase Transition. Diagram techniques. | **1** | 5 |
| | SSWT 6. Prepare the report: Quantum numbers. Parity. C, P and T transformations. | **1** | 20 |
| **14** | L-14. Higgs Mechanism, GlashowSalam-Weinberg Model. | **2** | - |
| | S-14. Neutrino Oscillations and Masses. | **1** | 5 |
| **15** | L-15**.** Hadrons and Quarks, Quantum Chromodynamics. Grand Unification. | **2** | - |
| | S-15**.** Inflation, Supersymmetry, Superstrings. | **1** | 5 |
| | SSW 7. Prepare the report: Inflation, Supersymmetry, Superstrings | **1** | 25 |
| | **2nd Intermediate Control (IC2)** | | **100** |
| | **Exam** | | **100** |
| | **Total** | | **100** |
| **Note: Independent work of students with teacher is 7 hours for semester. 3, 5, 7, 9, 11, 13 and 15 weeksareincludedintosyllabus (assignmentsubmission)** | | | |

Lecturer_____TakibayevN.Zh.
Head of the Department_____Abishev M.E.
Chairman of the Faculty Methodical Bureau_____A.T.Gabdullina A.T.