

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

APPROVED  
 Dean of the Faculty  
 \_\_\_\_\_ Davletov A.E.  
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**Syllabus**  
**autumn semester, 2017-2018 academic year**

**Academic course information**

Discipline's code	Discipline's title	Type	No. of hours per week			Number of credits	ECTS
			Lect.	Pract.	Lab.		
<b>5303 VTS</b>	Introduction to the theory of supersymmetry	Basic	2	1	0	3	5
Lecturer	Takibayev N.Zh., d.s.p.-m., academic of NAS RK, professor			Office hours		Scheduled	
e-mail	E-mail: <a href="mailto:takibayev@gmail.com">takibayev@gmail.com</a>						
Telephone number	Telephone: 2925-133; 8-777-704-0396			Auditory		319	

Academic presentation of the course	<p><b>Type of course</b> (theoretical, practical; basic, elective) and its purpose (role and place of the course in the educational program): Theoretical Nuclear Physics.</p> <p><b>The aim of the course:</b> to give the students the deep understanding of the modern 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: *</p> <p>A) cognitive: be able to - demonstrate acquired knowledge (specifically) and it's understanding; - demonstrate an understanding of the overall structure of the study field and the relations between its elements (specifically);</p> <p>B) functional: 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; **</p> <p>C) systemic: be able to - synthesize, interpret and evaluate the learning outcomes of discipline, modules, midterm exam content (specifically); make an analysis of</p> <p>D) Social: 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;</p> <p>E) metacompetences: 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</p>
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	and learning of educational material and to achieve learning outcomes of the course (individual researches, group projects, case studies and other methods).
Prerequisites	Mathematical analysis, the theory of functions of complex variables, differential equations, mathematical physics, statistical physics, physics of elementary particles.
Post requisites	Actual problems of physics and ecology, trends in the development of technology and environmental problems, Problems of energy and nanotechnologies, Modern problems of space ecology and physics.
Information resources	<p><b>Literature:</b></p> <ol style="list-style-type: none"> <li>1. M. Kaku: Introduction to superstrings and M- Theory, Springer, 624 (1999).</li> <li>2. J. Wess, J. Bagger: Supersymmetry and Supergravity, Princeton University Press (1992).</li> <li>3. E. Witten, "Constraints on supersymmetry breaking", Nucl. Phys. <b>B202</b>, 253(1982).</li> <li>4. S.P. Martin, "A supersymmetry primer", ArXiv:hep-ph/9709356.</li> <li>5. J.D. Lykken, "Introduction to supersymmetry", ArXiv:hep-th/9612114.</li> <li>6. A. Bilal, "Introduction to Supersymmetry", ArXiv:hep-th/0101055.</li> <li>7. D.I. Kazakov, «Supersymmetric expansion of the Standard model of fundamental interactions», the works of the summer school of the «Dynasty» foundation «Physics of fundamental interactions», (2006 ).</li> <li>8. M. Shifman, A. Vainshtein, "Instantons Versus Supersymmetry: Fifteen years later," ArXiv:hep-th/9902018.</li> </ol> <p><b>Internet-resources:</b></p> <ol style="list-style-type: none"> <li>1. Krasnikov N V, Matveev V A hep-ph/9703204</li> <li>2. Y.A. Golfand, E.P. Likhtman, JETP Lett. <b>13</b> 452 (1971)</li> <li>3. Volkov D V, Akulov V P Phys. Lett. B <b>46</b> 109 (1973)</li> <li>4. Wess J, Zumino B Nucl. Phys. B <b>70</b> 39(1974)</li> </ol>
Academic policy of the course in the context of university moral and ethical values	<p><b>Academic Behavior Rules:</b> 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.</p> <p><b>Academic values:</b> Inadmissibility of plagiarism, forgery, cheating at all stages of the knowledge control, and disrespectful attitude towards teachers. (The code of KazNU Student's honor)</p>
Evaluation and attestation policy	<p><b>Criteria-based evaluation:</b> Assessment of learning outcomes in correlation with descriptors (verification of competence formation during midterm control and examinations).</p> <p><b>Summative evaluation:</b> evaluation of the presence and activity of the work in the classroom; assessment of the assignment, independent work of students, (project / case study / program / ...)</p>

Calendar (schedule) the implementation of the course content:

Wee ks	Topic title (lectures, practical classes, Independent work of students)	Numbe r of hours	Maximum score
<b>Module 1</b>			

<b>1</b>	Lecture-1 (L-1). Continuous integrals and point particles.	<b>2</b>	-
	Seminar -1 (S-1). Relativistic point particles.	<b>1</b>	8
<b>2</b>	L-2. Secondary quantization. Harmonic oscillators.	<b>2</b>	-
	S-2. Currents and secondary quantization.	<b>1</b>	8
<b>3</b>	L-3. The strings of Nambu-Goto.	<b>2</b>	-
	S-3. Boson strings.	<b>1</b>	8
	SSW-3. Quantization in the calibration of a light cone.	<b>1</b>	8
<b>4</b>	L-4. Two-dimensional supersymmetry.	<b>2</b>	-
	S-4. Closed strings.	<b>1</b>	8
	SSW-4. Destruction of spirits.	<b>1</b>	8
<b>Module 2</b>			
<b>5</b>	L-5. Supersymmetry	<b>2</b>	-
	S-5. Supersymmetric point particles.	<b>1</b>	8
	SSW-5. Quantization.	<b>1</b>	8
<b>6</b>	L-6. Two-dimensional supersymmetry. Trees.	<b>2</b>	-
	S-6. Local two-dimensional supersymmetry.	<b>1</b>	8
	SSW-6. Superstrings.	<b>1</b>	8
<b>7</b>	L-7. Conformal field theory and the Kac-Moody algebra.	<b>2</b>	-
	S-7. Conformal field theory.	<b>1</b>	8
	SSW-7. Superconformal field theory.	<b>1</b>	12
	<b>1st Intermediate Control (IC1)</b>		<b>100</b>
<b>8</b>	<b>Midterm (MT)</b>		<b>100</b>
	L-8. Fermion vertex operator. Spinors and trees.	<b>2</b>	-
	S-8. The Kac-Moody algebras.	<b>1</b>	8
	SSW-8. Supersymmetry.	<b>1</b>	6
<b>Module 3</b>			
<b>9</b>	L-9. Multi-loop amplitudes and Teichmüller spaces.	<b>2</b>	-
	S-9. Unitarity. One-loop amplitudes.	<b>1</b>	8
	SSW-9. Harmonic oscillators.	<b>1</b>	6
<b>10</b>	L-10. Field theory in the calibration of the light cone.	<b>2</b>	-
	S-10. Вывод полевой теории точечных частиц.	<b>1</b>	6
	SSW-10. Field theory of superstrings.	<b>1</b>	6
<b>11</b>	L-11. Field theory of BRST.	<b>2</b>	-
	S-11. Covariant field string theory.	<b>1</b>	6

	SSW-11. Closed strings and superstrings.	<b>1</b>	<b>6</b>
<b>12</b>	L-12. Geometric field string theory.	<b>2</b>	<b>-</b>
	S-12 String group.	<b>1</b>	<b>6</b>
	SSW-12. Geometrical output of the action.	<b>1</b>	<b>6</b>
<b>13</b>	L-13. Anomalies and the Atiyah-Singer theorem.	<b>2</b>	<b>-</b>
	S-13. Anomalies and Feynman diagrams.	<b>1</b>	<b>6</b>
	SSW-13. Reduction of anomalies in string theory.	<b>1</b>	<b>6</b>
<b>14</b>	L-14. Heterotic strings and compactification.	<b>2</b>	<b>-</b>
	S-14. Spectrum of states. Covariant and fermion formulations.	<b>1</b>	<b>6</b>
	SSW-14. A ten-dimensional theory without supersymmetry	<b>1</b>	<b>6</b>
<b>15</b>	L-15. On the theory of supersymmetry.	<b>2</b>	<b>-</b>
	S-15. Four-dimensional superstrings.	<b>1</b>	<b>6</b>
	SSW-15. Review of the theory of supersymmetry.	<b>1</b>	<b>6</b>
	<b>2nd Intermediate Control (IC2)</b>		<b>100</b>
	<b>Exam</b>		<b>100</b>
<b>Independent work of students with teacher is 7 hours for semester. 3, 5, 7, 9, 11, 13 and 15 weeks are included into syllabus (assignment submission)</b>			

Lecturer \_\_\_\_\_ Takibayev N.Zh.

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

Chairman of the Faculty Methodical Bureau \_\_\_\_\_ A.T.Gabdullin