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

APPROVED by
Dean of Faculty
Davletov A.E.
"31" 08 2018

EDUCATIONAL-METHODICAL COMPLEX OF DISCIPLINE

ACST 7303 «Additional chapters of scattering theory»

Specialty "6D060500 – Nuclear Physics"
Educational program on specialty "6D060500 – Nuclear Physics"

Course – 1
Semester – 1
Number of credits – 3

Almaty 2018

Educational-methodical complex of the discipline is made by Takibayev N.Zh., d.s.p.-m., academic of NAS RK, professor lecturer (name, surname, scientific degree, academic rank)

Based on the working curriculum on the specialty "6D060500 – Nuclear Physics"

Considered and recommended at the meeting of the department Theoretical and Nuclear Physics

from «__28_» ___08___ 2018 year, protocol № 1

Head of department _____ Abishev M.E.
(Signature)

Recommended by methodical bureau of the faculty

«__31__» __08__ 2018 year, protocol № 1

Chairman of the method bureau of the faculty _____ Gabdullina A.T.
(Signature)

Syllabus

on discipline (ACST 7303) "Additional chapters of scattering theory"

for specialty **"6D060500 - Nuclear Physics"**

Autumn semester, 2018-2019 academic year,

Course 1

Academic course information

Discipline's code	Discipline's title	Type	No. of hours per week			Number of credits	ECTS
			Lect.	Pract.	Lab.		
ACST 7303	Additional chapters of scattering theory	Elective	1	2	0	3	5

Lecturer	Takibayev N.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

Academic presentation of the course	The training course "Additional chapters of scattering theory" is **an elective** component in educational program of **doctoral student on specialty "6D060500 – Nuclear Physics"** **The aim of the course:** learning the modern physics of atomic nuclei and quantum mechanics for systems consisting of few-particles and clusters. As a result of the discipline, the student will be able to: 1. describe acquired knowledge (specifically) and it's understanding; 2. interpret an understanding of the overall structure of the study field and the relations between its elements (specifically); 3. generalize new knowledge in the context of basic knowledge, interpret its contents; 4. create educational and social interaction and cooperation in the group; 5. explain the solution of the problem, its importance; 6. classify criticism and to criticize; 7. decide to work in a team; 8. combine 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; 9. design active and interactive methods which are recommended to ensure deeper understanding and learning of educational material 10. achieve learning outcomes of the course (individual researches, group projects, case studies and their methods).
Prerequisites	Mathematical analysis, the theory of functions of complex variables, differentialequations, mathematical physics, statistical physics, physics of elementaryparticles.
Post requisites	Taken knowledge will be used in research work.
Information	Literatures (with an indication of the authors and data output), the

resources	availability(number), software and consumables with information about where you can get them. 1. Lectures of the European school on theoretical methods for electron and positron induced chemistry, Prague, Feb. 2005 2. E. Koelink, Lectures on scattering theory, Delft the Netherlands 200 3. H.Friedrich, Scattering Theory, Fachbereich Physik T 30aTU München Garching Germany, 2015 4. John R. Taylor Scattering Theory: The Quantum Theory of Nonrelativistic Collisions, 512 pages, Dover Publications, May 26, 2006 5. Ta-you Wu, Takashi Ohmura, Quantum Theory of Scattering, 528 pages, Dover Publications, July 19, 2011 6. D.S. Sivia, Elementary Scattering Theory: For X-ray and Neutron Users, 216 pages, Oxford University Press; 1 edition,January 29, 2011 7. Roger G. Newton, Scattering Theory of Waves and Particles: Second Edition, 768 pages, Dover Publications; Second edition, June 19, 2013 8. R.Blumenhagen, D.Lüst, S.Theisen, Basic Concepts of String Theory, 784 pages, Springer; 2013 edition, October 4, 2012
Academic policy of the course in the context of university moral and ethical values	**Academic Behavior Rules:** 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. **Academic values:** Inadmissibility of plagiarism, forgery, cheating at all stages of the knowledge control, and disrespectful attitude towards teachers. (The code of KazNU Student`s honor)
Evaluation and attestation policy	**Criteria-based evaluation:** Assessment of learning outcomes in correlation withdescriptors (verification of competence formation during midterm control andexaminations). **Summative evaluation:** evaluation of the presence and activity of the work in the classroom; assessment of the assignment, independent work of students, (project/casestudy/ program/...) The formula for calculating the final grade. $$\text{Final grade for the discipline} = \frac{IC1 + IC2}{2} \cdot 0{,}6 + 0{,}1MT + 0{,}3FC$$ Below are the minimum estimates in percentage terms: 95% - 100%: A; 90% - 94%: A-; 85 % - 89%: B 80% - 84%: B; 75% - 79%: B-; 70% - 74%: C+ 65% - 69%: C; 60% - 64%: C-; 55% - 59%: D+ 50% - 54%: D-; 0% -49%: F

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). Formulation of scattering theory in terms of representation theory	1	-
	Seminar -1 (S-1).Type of scattering matrix	2	5

2	L-2.The discrete spectrum. The virial theorem	1	-
	S-2.Same particles and statistical physics	2	5
3	L-3. Continuous spectrum	1	-
	S-3The scattering operator in the continuous case	2	5
	DSWT 1.Assignment submission№ 1: Representation theory (prepare the report)	1	20
4	L-4. Analytic properties of the wave function	1	-
	S-4. S-matrix. dispersion relations.	2	5
	Module 2		
5	L-5.Spectral theory	1	-
	S-5. The Green's function and perturbation theory	2	5
	DSWT 2.Assignment submission № 2:The operators associated with the scattering matrix (prepare the presentation)	1	20
6	L.-6.Applications of spectral theory	1	-
	S.-6. Operator algebra. The time Green's function	2	5
7	L.-7.Translational representation for the solution of the wave equation in free space	1	-
	S.-7. The wave function in the semiclassical approximation	2	5
	DSWT 3.Assignment submission№ 3: Translational representation for the solution of the wave equation in free space (in oral form)	1	25
	1st Intermediate Control (IC1)		**35+65=100**
8	**Midterm (MT)**		**100**
	L-8.Quantum oscillator under the influence of an external force	1	-
	S-8.Parametric excitation of a quantum oscillator	2	5
	Module 3		
9	L-9. The scattering matrix	1	-
	S-9. Heisenberg representation and canonical transformations	2	5
	DSWT4. Assignment submission № 4:Generalization of the normalization and perturbation theory for quasi stationary states (prepare the presentation)	1	10
10	L-10. Wave function of a multichannel system	1	-
	S-10. Section. Unitarity and symmetry of the S matrix.	2	5
11	L-11. S matrix and its relation to the R-matrix	1	-
	S-11.Threshold phenomena.	2	5
	DSWT5. Assignment submission № 5: Energy dependence of the scattering cross section near the threshold of reactions. Generalization to the case of particles with spin. (prepare the report)	1	10
12	L-12.The Faddeev equations	1	-
	S-12. General formulas for scattering cross sections	2	5

13	L-13. The motion of two particles in an external potential field	1	-
	S-13. The formula for determining the amplitudes of various processes	2	5
	DSWT 6. Assignment submission № 6:Asymptotics of the wave function at large distances. (prepare the presentation)	1	20
14	L-14.Theory of weak interactions	1	-
	S-14.Reactions with neutrino emission	2	5
15	L-15.Quasienergy of a system subjected to periodic action	1	-
	S-15.Multiplication in the case of several channels	2	5
	DSWT 7. Assignment submission№ 7: Properties of highly excited levels in the Coulomb field. (in oral form)	1	25
	2nd Intermediate Control (IC2)		**35+65=100**
	Exam		**100**
	Total		**100**

Lecturer _____ Takibayev N.Zh.
Head of the Department _____ Abishev M.E.
Chairman of the Faculty Methodical Bureau _____ Gabdullina A.T.