TAJIK NATIONAL UNIVERSITY
DEPARTMENT OF THEORETICAL PHYSICS

DESCRIPTION (EXTENDED WORK PROGRAM) FOR THE COURSE OF THEORETICAL MECHANICS FOR 2ND-YEAR STUDENTS OF SPECIALTY 31040103 - "PHYSICS" OF THE PHYSICS FACULTY

Subject: theoretical mechanics
Specialty: "Physics"
Volume of academic hours: 2 credits (48 hours), including:
lectures - 24 hours,
practical classes - 24 hours.
Course: 2
Semester: 4

Dushanbe - 2025

Description (extended work program) is developed on the basis of the State Educational Standard of the specialty 31040103 - "Physics", approved by the Board of the Ministry of Education and Science of the Republic of Tajikistan dated 28.12.2017 No. 18/74.

Description (extended work program) was developed by Associate Professor of the Department of Theoretical Physics Odilov O.Sh.

Description was reviewed and approved at the meeting of the Department of Theoretical Physics 24 01. 2025, protocol № 7.

Head of Department Odilov O.Sh.

Reviewed and approved by the Methodological Commission of the Physics Department (Protocol №. 5 dated "25" 01. 2025),
Chairman of the Methodological Commission of the Physics Department Istamov F.

Information about the subject teacher:
Alisheri Mahmalatif - Candidate of Physical and Mathematical Sciences, Associate Professor of the Department of Theoretical Physics of the Physics Department of the Tajik National University.

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II. EXPLANATION OF THE POSITION OF THE SUBJECT IN THE EDUCATIONAL PROCESS

The discipline "Theoretical Mechanics" as a compulsory course is included in the curriculum of the physics specialty of the physics faculty and is necessary for the formation of qualified specialists from students. When studying the discipline, students must master the basic laws of kinematics and dynamics of a point, as well as a rigid body, mechanical vibrations, relative and complex motion, the motion of bodies in the field of central forces, etc.

III. OBJECTIVES OF STUDYING THE DISCIPLINE

The objectives of mastering the discipline are to form students' knowledge of mechanical movements and their patterns, to develop the scientific ability of students during participation in seminars, conferences and professional activities.

IV. COURSE OBJECTIVES:

• to define the basic concepts of theoretical mechanics (space, time, motion, etc.) and explain their roles in studying the course;
• study kinematic quantities (displacement, speed, acceleration, etc.) and determine their role in studying the course;
• gain knowledge about the dynamics of a material point and a rigid body (dynamic theorems, oscillations, motion in the field of central forces, etc.);
• develop in students the skill of solving various qualitative and quantitative problems;

V. FINAL RESULTS OF MASTERING THE DISCIPLINE

As a result of mastering the discipline, the student should:
- master the basic concepts of theoretical mechanics;
- be able to determine the basic kinematic quantities using different methods for determining the law of motion of a point;
- master and understand the essence and content of the basic laws of dynamics;
- understanding the essence of conservation laws, use them in solving practical problems;

Prerequisites (connection of the discipline with other subjects mastered by the student) subjects mastered by the student during the period of study at a general educational institution of secondary education: physics, mathematics, computer science.

Postrequisites: (connection of the discipline with other subjects that the student studies during the course of study along with theoretical mechanics): electrodynamics, quantum mechanics, statistical physics, etc.

VI. CONTENT OF THE DISCIPLINE

Week	№ п/п	NAMES OF CLASSROOM SESSION TOPICS		CPC (outside the classroom)	Number of hours	Completion date	Possible points	Literature
		lectures	practical classes					
I	1	Subject of theoretical mechanics and basic concepts of coordinate systems. Methods of determining the law of motion of a material point (2 hours).		Subject of theoretical mechanics and basic concepts of coordinate systems. Methods of determining the law of motion of a material point (1 hour).	3			1–8
	2		Subject of theoretical mechanics and basic concepts of coordinate systems. (seminar) (1 hour).		1			1–8
II	3	Velocity of a material point and determination of its components in various coordinate systems. Sectoral velocity and its components in various coordinate systems (2 hours).		Velocity of a material point and determination of its components in various coordinate systems. Sectoral velocity and its components in various coordinate systems (1 hours).	3			1–8

	4		Solving problems on linear and sectoral speeds (1 hour).		1			1–8
III	5	Velocity of a material point and determination of its components in various coordinate systems. Sectoral velocity and its components in various coordinate systems (2 hours).		Acceleration of a material point. Acceleration components in cylindrical and natural coordinates (1 hour).	3			1–8
	6		Solving problems on the topic of acceleration of a point (1 hour).		1			1–8
IV	7	Basic laws of dynamics. Differential equation of motion of a material point. Direct and inverse problems of dynamics. (2 hours).		Basic laws of dynamics. Differential equation of motion of a material point. Direct and inverse problems of dynamics. (1 hour).	3			1–8
	8		Seminar on the topic of differential equation of motion of a material point (1 hour).		1			1–8

V	9	Integration of differential equations of motion. Initial conditions. Integrals of motion. Particular cases of integration of differential equations of motion. (2 hours).		Integration of differential equations of motion. Initial conditions. Integrals of motion. Particular cases of integration of differential equations of motion. (1 hour).	3			1–8
	10		Solving problems on the topic of integration of the differential equation of motion (1 hour).		1			1–8
VI	11	Laws of conservation and change of momentum of a material point. Laws of conservation and change of angular momentum of a material point. Law of change of kinetic energy of a material point. Work and power. (2 hours).		Laws of conservation and change of momentum of a material point. Laws of conservation and change of angular momentum of a material point. Law of change of kinetic energy of a material point. Work and power. (1 hour).	3			1–8
	12		Solving problems on conservation laws (1 hour).		1			1–8

VII	13	Force fields. Potential forces. Potential and total energy of a material point (2 hours).		Force fields. Potential forces. Potential and total energy of a material point (1 hour).	3			1–8
	14		Solving problems on the topic of potential and total energy (1 hour).		1			1–8
VIII	15	Motion of a material point in the field of central forces. Motion of a material point in the field of forces inversely proportional to the square of the distance. Motion of a material point in the Earth's gravitational field. Cosmic velocities. (2 hours).		Motion of a material point in the field of central forces. Motion of a material point in the field of forces inversely proportional to the square of the distance. Motion of a material point in the Earth's gravitational field. Cosmic velocities. (2 hours).	3			1–8
	16		Solving problems on the topic of the motion of a material point in a field of central forces. (1 hour).		1			1–8

IX	17	Kepler's laws. Scattering of particles in the field of central forces. Rutherford's formula (2 hour).		Kepler's laws. Scattering of particles in the field of central forces. Rutherford's formula (1 hour).	3			1–8
	18		Solving problems on the topic of particle scattering in the field of central forces. (1 hour).		1			1–8
X	19	Motion under imposed constraints. Superposition of constraints. Holonomic and non-holonomic constraints. Virtual displacements. Ideal constraints. (2 hours).		Motion under imposed constraints. Superposition of constraints. Holonomic and non-holonomic constraints. Virtual displacements. Ideal constraints.	3			1–8
	20		Solving problems on the topic of motion under imposed constraints. (1 hour).		1			1–8
XI	21	Dynamic principle of virtual movements. (2 hours).		Static principle of virtual displacements.	3			1–8

	22		Solving problems on the topic Dynamic principle of virtual displacements. (1 hour).		1			1–8
XII	23	Method of undetermined multipliers. Lagrange equations of the first kind. (2 hours).		Method of undetermined multipliers. Lagrange equations of the first kind	3			1–8
	24		Solving problems on the topic of the Lagrange equation of the first kind. (1 hour).		1			1–8
XIII	25	Method of generalized coordinates. Lagrange equations of the 2nd kind. Lagrange function. (2 hours).		Method of generalized coordinates. Lagrange equations of the 2nd kind. Lagrange function.	3			1–8
	26		Solving problems on the topic of the Lagrange equation of the 2nd kind. (1 hour).		1			1–8

XIV	27	Transformation to first order equations. Canonical equations. Hamilton function. (2 hours).		Transformation to first order equations. Canonical equations. Hamilton function	3			1–8
	28		Solving problems on the topic of canonical equations. (1 hour).		1			1–8
XV	29	Small oscillations. Free oscillation of a material point. Free oscillation of a material point taking into account friction. (2 hours).		Small oscillations. Free oscillation of a material point. Free oscillation of a material point taking into account friction. (1 hour).	3			1–8
	30		Solving problems on the topic of free vibrations. (1 hour).		1			1–8
XVI	31	Forced oscillations. Resonance. Non-harmonic oscillations. (2 hours).		Forced oscillations. Resonance. Non-harmonic oscillations. (1 hour).	3			1–8
	32		Solving problems on the topic of forced oscillations (1 hour).		1			1–8

VII. Literature

1. V.G. Nevglyadov Theoretical mechanics. – M., 1959, – 576 p.
2. Ќ. Komilov, A.K. Zaripov. Mechanics Nazariyav. – D., 2013, – 411 p.
3. Targ S.M. Short course in theoretical mechanics. – M.: Higher. school, 1986, – 416 p.
4. Kilchevsky N.A. Course of theoretical mechanics, vol. I. – M.: Nauka, 1977, – 480 p.
5. Kilchevsky N.A. Course of theoretical mechanics, vol. II. – M.: Nauka, 1977, – 544 p.
6. I.M. Voronkov Course of theoretical mechanics. – M.: Nauka, 1964, 596 p.
7. K.E. Yakimova Problems in Theoretical Mechanics. – M., 2004, – 96 p.
8. I.I. Olkhovsky. Course in Theoretical Mechanics for Physicists. – M. , 1978, – 575 p.
9. I.I. Olkhovsky, Pavlenko, Kuzmenkov Problems in theoretical mechanics for physicists,

VIII. REQUIREMENTS FOR TEACHING THE DISCIPLINE. ASSESSMENT CRITERIA

The criteria for assessing knowledge include the logical presentation of the answer, the ability to analyze, and active participation in classes .

The assessment result will also be affected by failure to complete an assignment, missed classes without a valid reason, and inappropriate behavior during classes.

When attending classes, the following rules must be observed:

1. Do not be late for classes.
2. Do not miss classes without a good reason.
3. Make up missed classes at the time specified by the teacher.
4. Actively participate in classes, conscientiously complete all assignments.
5. According to the calendar schedule of the educational process, submit all types of tests on time.
6. Do not leave the audience without the teacher's permission.

7. Turn off cell phones and players.
8. Behave appropriately, observe the ethics of behavior in a public place.

The procedure for assigning probable (possible) grades to a student

Letter expression of the assessment	Numerical expression of the evaluation score	Percentage (%) of correct answers	Traditional system assessment
A	4,0	95 - 100	Great
A-	3,67	90 - 94	
B+	3,33	85 - 89	Fine
B	3,0	80 - 84	
B-	2,67	75 - 79	
C+	2,33	70 - 74	satisfactorily
C	2,0	65 - 69	
C-	1,67	60 - 64	
Д	1,33	55 - 59	
Д-	1,0	50 - 54	
U	0	0 - 49	unsatisfactory