Federal State Autonomous Educational Institution of Higher Education
Peoples' Friendship University of Russia named after Patrice Lumumba

Academy of Engineering

(name of the main educational unit (MEU) that developed the educational program of higher education)

WORKING PROGRAM OF THE DISCIPLINE

THEORETICAL MECHANICS

(name of discipline/module)

Recommended for the field of study/specialty:

27.03.04 CONTROL IN TECHNICAL SYSTEMS

(code and name of the field of study/specialty)

The discipline is mastered within the framework of the implementation of the main professional educational program of higher education (EP HE):

DATA SCIENCE AND SPACE SYSTEMS

(name (profile/specialization) of the educational institution of higher education)

2026

1. THE GOAL OF MASTERING THE DISCIPLINE

The "Theoretical Mechanics" course is part of the "Data Science and Space Systems" bachelor's program, focusing on 27.03.04 "Control in Technical Systems" and is studied in semesters 3 and 4 of the second year. The course is offered by the Department of Mechanics and Control Processes. It consists of four sections and 19 topics and focuses on the fundamentals of theoretical mechanics, point and rigid body kinematics, statics and dynamics of points and rigid bodies, and analytical mechanics. Particular attention is paid to the analysis of methods for solving typical problems and their application in professional activities.

The purpose of mastering the discipline is to improve the level of engineering literacy, to develop fundamental knowledge and skills in applying methods for solving mechanical problems necessary for professional activity and mastering subsequent disciplines.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Theoretical Mechanics" aimed at developing the following competencies (parts of competencies) in students:

Table 2.1. List of competencies developed in students while mastering the discipline (results of mastering the discipline)

Cipher	Competence	Indicators of Competency Achievement (within this discipline)
GPC-3	Able to use fundamental knowledge to solve basic control problems in technical systems in order to improve in professional activities	GPC-3.1 Knows the theoretical foundations and principles of mathematical modeling; GPC-3.2 Able to develop and use methods of mathematical modeling, information technologies to solve problems of applied mathematics; GPC-3.3 Possesses practical skills in solving problems of applied mathematics, methods of mathematical modeling, information technologies and the basics of their use in professional activities, skills of professional thinking and an arsenal of methods and approaches necessary for the adequate use of methods of modern mathematics in theoretical and applied problems;
GPC-5	Capable of solving problems of development of science, engineering and technology in the field of management in technical systems, taking into account the legal framework in the field of intellectual property	GPC-5.1 Knows the theoretical foundations of digital technologies, the basics of modeling objects of professional activity, the basics of data analysis and presentation of information; GPC-5.2 Able to solve problems of professional activity using existing methods of modeling, data analysis, and information presentation; GPC-5.3 Possesses skills in developing algorithms and computer programs suitable for practical application;
PC-4	Able to formulate, analyze and solve engineering problems in the field of ballistics, motion mechanics and spacecraft motion control based on professional knowledge	PC-4.1 Knows the basic concepts and basic algorithms for solving problems in the field of ballistics, motion mechanics and motion control based on automated and automatic systems; PC-4.2 Able to solve engineering problems of an analytical nature in the field of ballistics, motion mechanics and spacecraft motion control based on professional knowledge; PC-4.3 Possesses skills in using mathematical methods for processing information obtained as a result of experimental studies, basic methods for analyzing the mechanics of motion and controlling the motion of spacecraft based on standard methods and software packages;

3. PLACE OF THE DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL EDUCATIONAL INSTITUTION

Discipline "Theoretical Mechanics" refers to the mandatory part of block 1 “Disciplines (modules)” of the educational program of higher education.

As part of the higher education program, students also master other disciplines and/or practices that contribute to the achievement of the planned results of mastering the discipline "Theoretical Mechanics".

Table 3.1. List of components of the educational program of higher education that contribute to the achievement of the planned results of mastering the discipline

Cipher	**Name of competence**	**Previous courses/modules, practical training***	**Subsequent disciplines/modules, practices***
GPC-3	Able to use fundamental knowledge to solve basic control problems in technical systems in order to improve in professional activities	Mathematical analysis; Algebra and Geometry;	Research work / Scientific research work; Technological Training; Undergraduate Training; Space Flight Mechanics; Numerical Methods; Automatic Control Theory; Equations of mathematical physics; Optimal Control Methods; Analysis of Geoinformation Data;
GPC-5	Capable of solving problems of development of science, engineering and technology in the field of management in technical systems, taking into account the legal framework in the field of intellectual property		Research work / Scientific research work; Technological Training; Undergraduate Training; Automatic Control Theory; Analysis of Geoinformation Data;
PC-4	Able to formulate, analyze and solve engineering problems in the field of ballistics, motion mechanics and spacecraft motion control based on professional knowledge		Research work / Scientific research work; Technological Training; Undergraduate Training; Space Flight Mechanics; Optimal Control Methods;

* - filled in accordance with the competency matrix and the SUP EP HE

** - elective courses/practices

4. SCOPE OF THE DISCIPLINE AND TYPES OF EDUCATIONAL WORK

The total workload of the discipline “Theoretical Mechanics” is 8 credit units.

Table 4.1. Types of educational work by periods of mastering the educational program of higher education for full-time education.

Type of academic work	**TOTAL,**academic hours		**Semester(s)**	
			3	**4**
Contact work, academic hours	*140*		*72*	*68*
Lectures (LC)	70		36	34
Laboratory work (LW)	0		0	0
Practical/seminar classes (SC)	70		36	34
Independent work of students, academic hours	*94*		*81*	*13*
Control (exam/test with assessment), academic hours	*54*		*27*	*27*
Total complexity of the discipline	**academic hours**	***288***	*180*	*108*
	credit	***8***	*5*	*3*

The total workload of the discipline “Theoretical Mechanics” is 8 credit units.

Table 4.2. Types of educational work by periods of mastering the educational program of higher education for full-time education.

Type of academic work	**TOTAL,**academic hours		**Semester(s)**	
			3	**4**
Contact work, academic hours	*140*		*72*	*68*
Lectures (LC)	70		36	34
Laboratory work (LW)	0		0	0
Practical/seminar classes (SC)	70		36	34
Independent work of students, academic hours	*94*		*81*	*13*
Control (exam/test with assessment), academic hours	*54*		*27*	*27*
Total complexity of the discipline	**academic hours**	***288***	*180*	*108*
	credit	***8***	*5*	*3*

The total workload of the discipline “Theoretical Mechanics” is 8 credit units.

Table 4.3. Types of educational work by periods of mastering the educational program of higher education for full-time education.

Type of academic work	**TOTAL,**academic hours		**Semester(s)**	
			3	**4**
Contact work, academic hours	*140*		*72*	*68*
Lectures (LC)	70		36	34
Laboratory work (LW)	0		0	0
Practical/seminar classes (SC)	70		36	34
Independent work of students, academic hours	*94*		*81*	*13*
Control (exam/test with assessment), academic hours	*54*		*27*	*27*
Total complexity of the discipline	**academic hours**	***288***	*180*	*108*
	credit	***8***	*5*	*3*

5. CONTENT OF THE DISCIPLINE

Table 5.1. Content of the discipline (module) by types of academic work

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
Section 1	Introduction	1.1	Theoretical mechanics in the structure of scientific and technical knowledge. Areas of application of theoretical mechanics methods	Theoretical mechanics among fundamental and applied sciences, the main sections of theoretical mechanics: statics, kinematics and dynamics, areas of application of theoretical mechanics methods in engineering, mechanical engineering, construction, aircraft manufacturing and robotics	OK
		1.2	Vector theory. Projections and coordinates of vectors. Operations on vectors in coordinate representation. Differentiation of a vector function with respect to a scalar argument.	Theoretical mechanics in the structure of scientific and technical knowledge, its place among fundamental and applied sciences, the main sections of theoretical mechanics: statics, kinematics and dynamics, areas of application of theoretical mechanics methods in engineering, mechanical engineering, construction, aircraft manufacturing and robotics	LC, SC
Section 2	Kinematics	2.1	Kinematics of a point	Basic concepts of kinematics: space, time, trajectory, path, displacement, methods of specifying the motion of a point (vector, coordinate, natural), velocity and acceleration vectors of a point, their projections onto the coordinate axes and natural axes, uniform and uniformly variable rectilinear motion, curvilinear motion, tangential and normal acceleration	LC, SC
		2.2	The simplest motions of a rigid body	Translational motion of a rigid body: definition, properties, trajectories, velocities and accelerations of points of the body during translational motion, rotational motion of a rigid body around a fixed axis: angular velocity and angular acceleration, uniform and uniform rotation, linear velocities and accelerations of points of a rotating body.	LC, SC
		2.3	Plane motion of a rigid body	Definition of plane (plane-parallel) motion, decomposition of plane motion into translational and rotational motion, equation of plane motion, instantaneous center of velocity and methods for finding it, determination of velocities and accelerations of points of a body during plane motion.	LC, SC
		2.4	Rotation of a rigid body around a fixed axis	Angular characteristics of rotational motion: angle of rotation, angular velocity, angular acceleration, vector representation of angular quantities, relationship between linear and angular characteristics of points of a rotating body	LC, SC
		2.5	General case of rigid body motion	Free motion of a rigid body, number of degrees of freedom, de-	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				composition of free motion into translational motion of the pole and spherical motion around the pole, kinematic characteristics of a free body	
		2.6	Complex point movement	Absolute, relative and translational motion of a point, the theorem on the addition of velocities, translational and relative velocities, the theorem on the addition of accelerations	LC, SC
		2.7	Complex motion of a rigid body	Addition of translational motions of a rigid body, addition of rotations around parallel axes, addition of rotations around intersecting axes, addition of rotations around crossing axes, screw motion as a result of addition of rotation and translational motion, instantaneous axis of rotation.	LC, SC
Section 3	Statics	3.1	Axioms and fundamental principles of statics	Basic concepts of statics: force, system of forces, equivalent systems of forces, resultant, balanced system of forces, absolutely rigid body, axioms of statics, connections and reactions of connections, classification of connections (smooth surface, thread, hinge, rigid fixing)	LC, SC
		3.2	Equilibrium of bodies	Plane system of forces: bringing a system of forces to a given center, principal vector and principal moment, equilibrium conditions for a plane system of forces in vector and analytical forms, moments of force relative to a point and an axis, pairs of forces and their properties, arbitrary spatial system of forces	LC, SC
		3.3	Friction	Static friction and sliding friction, Coulomb's laws for dry friction, coefficient of friction and friction angle, cone of friction, friction on an inclined plane, rolling and spinning friction, equilibrium of bodies taking into account frictional forces, friction in kinematic pairs and its influence on the equilibrium of mechanical systems.	LC, SC
		3.4	Center of gravity	Center of parallel forces and its coordinates, center of gravity of a rigid body as a special case of center of parallel forces of gravity, methods for determining the position of the center of gravity (symmetry method, method of dividing into simple figures, method of negative masses), coordinates of centers of gravity of homogeneous bodies of simple geometric shape	LC, SC
Section 4	Dynamics	4.1	Dynamics of a material point	Basic concepts of dynamics: mass, force, inertia, Newton's laws, inertial reference frames, differential equations of motion of a material point in vector, coordinate and natural forms, two main problems of the dynamics of a point: direct (determining forces for	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				a given motion) and inverse (determining motion for given forces)	
		4.2	Geometry of masses	The concept of the moment of inertia of a material point and a rigid body relative to an axis and a point, axial, centrifugal and polar moments of inertia, radius of inertia, moments of inertia of homogeneous bodies of simple geometric shape (rod, ring, disk, cylinder, ball)	LC, SC
		4.3	General theorems of dynamics	Theorem on the motion of the center of mass of a mechanical system, theorem on the change in the momentum of a system and a material point, theorem on the change in the angular momentum (kinetic moment), theorem on the change in the kinetic energy of a system, work of a force on the final displacement	LC, SC
		4.4	Rigid body dynamics	Translational motion of a rigid body and its reduction to the motion of the center of mass, rotational motion of a rigid body around a fixed axis (differential equation of rotational motion), plane-parallel motion of a rigid body	LC, SC
		4.5	D'Alembert's principle. Dynamic reactions of constraints	D'Alembert's principle for a material point and a mechanical system, inertial forces, kinetostatic method, reduction of the inertial forces of a rigid body to its simplest form for various types of motion (translational, rotational, planar), determination of dynamic reactions of constraints, complete reactions of constraints and their components	LC, SC
		4.6	Fundamentals of Analytical Mechanics	Connections and their classification (holonomic and non-holonomic, stationary and non-stationary), possible displacements and the number of degrees of freedom, generalized coordinates and generalized forces, the principle of possible displacements, the general equation of dynamics	LC, SC

* - to be completed only for FULL-TIME education: LC – lectures; LW – laboratory work; SC – practical/seminar classes.

6. LOGISTIC AND TECHNICAL SUPPORT OF DISCIPLINE

Table 6.1. Material and technical support for the discipline

Audience type	Equipment of the auditorium	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	A lecture hall equipped with specialized furniture, a whiteboard (screen), and multimedia presentation equipment.	Projector
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with a set of specialized furniture and technical means for multimedia presentations.	No
For independent work	A classroom for independent student work (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to the Electronic Information System.	No

* - the classroom for independent work of students MUST be indicated!

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Main literature:

1. Course of Theoretical Mechanics: Textbook for Universities. 5th ed., corrected / Drong V. I., Dubinin V. V., Ilyin M. M. [et al.]; eds. Kolesnikov K. S., Dubinin V. V. — Moscow: Publishing house of Bauman Moscow State Technical University, 2017. 5th ed., corrected. 580 p. ISBN 978-5-7038-4568-4

2. A Brief Course in Theoretical Mechanics. 20th ed., reprinted / Targ S.M. - M.: Higher School, 2010. - 416 p. ISBN 978-5-06-006193-2

3. Meshcherskii, I. V. Problems in Theoretical Mechanics: a tutorial / I. V. Meshcherskii; edited by V. A. Palmov, D. R. Merkin. - 52nd ed., reprinted. - St. Petersburg: Lan, 2019. - 448 p. - ISBN 978-5-8114-4190-7. - Text: electronic // Lan: electronic library system. - URL: https://e.lanbook.com/book/115729 (accessed: 07.05.2023). - Access mode: for authorized users.

4. Collection of short problems in theoretical mechanics: a tutorial / edited by O. E. Kepe. - 7th ed., reprinted - St. Petersburg: Lan, 2020. - 368 p. - ISBN 978-5-8114-5266-8. - Text: electronic // Lan: electronic library system. - URL: https://e.lanbook.com/book/138186 (accessed: 05/07/2023). - Access mode: for authorized users.

Further reading:

1. Bat, M. I. Theoretical mechanics in examples and problems: a tutorial / M. I. Bat, G. Yu. Dzhanelidze, A. S. Kelzon. - 12th ed., reprinted. - St. Petersburg: Lan, [b. g.]. - Volume 1: Statics and kinematics - 2013. - 672 p. - ISBN 978-5-8114-1035-4. - Text: electronic // Lan: electronic library system. - URL: https://e.lanbook.com/book/4551 (accessed: 05/07/2023). - Access mode: for authorized users.

2. Bat', M. I. Theoretical Mechanics in Examples and Problems: a tutorial / M. I. Bat', G. Yu. Dzhanelidze, A. S. Kelzon. - 10th ed., reprinted. - St. Petersburg: Lan', [b. g.]. - Volume 2:

Dynamics - 2013. - 640 p. - ISBN 978-5-8114-1021-7. - Text: electronic // Lan': electronic library system. - URL: https://e.lanbook.com/book/4552 (accessed: 05/07/2023). - Access mode: for authorized users.

3. Dievsky, V. A. Theoretical Mechanics: a textbook / V. A. Dievsky. - 4th ed., corrected. and add. - St. Petersburg: Lan, 2016. - 336 p. - ISBN 978-5-8114-0606-7. - Text: electronic // Lan: electronic library system. - URL: https://e.lanbook.com/book/71745 (date of access: 05/07/2023). - Access mode: for authorized users.

4. Babicheva, I. V. Theoretical Mechanics. Examples and Tasks for Independent Work: a tutorial / I. V. Babicheva, I. A. Abramova. - St. Petersburg: Lan, 2020. - 208 p. - ISBN 978-5-8114-4317-8. - Text: electronic // Lan: electronic library system. - URL: https://e.lanbook.com/book/138154 (accessed: 05/07/2023). - Access mode: for authorized users.

Resources of the information and telecommunications network "Internet":

1. RUDN University Electronic Library System and third-party electronic library systems to which university students have access based on concluded agreements

- Electronic library system of RUDN - ELS RUDN http://lib.rudn.ru/MegaPro/Web
- Electronic Library System "University Library Online" http://www.biblioclub.ru
- EBS Yurayt http://www.biblio-online.ru
- Electronic Library System "Student Consultant" www.studentlibrary.ru
- Electronic Library System "Troitsky Bridge"
- EBS "Lan"

2. Databases and search engines

- electronic fund of legal and regulatory documentation http://docs.cntd.ru/
- Yandex search engine https://www.yandex.ru/
- Google search engine https://www.google.ru/
- SCOPUS abstract database http://www.elsevierscience.ru/products/scopus/

Educational and methodological materials for independent work of students in mastering a discipline/module:*

1. Lecture course on the subject "Theoretical Mechanics".

* - all teaching and methodological materials for independent work of students are posted in accordance with the current procedure on the discipline page in TUIS!

DEVELOPER:

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