

Документ подписан простой электронной подписью  
Информация о владельце:  
ФИО: Ястребов Олег Александрович  
Должность: Ректор  
Дата подписания: 25.05.2026 14:45:34  
Уникальный программный ключ:  
ca953a0120d891083f939673078ef1a989dae18a

**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**

### **APPLIED MECHANICS AND ENGINEERING**

---

(name of discipline/module)

**Recommended for the field of study/specialty:**

#### **01.04.02 APPLIED MATHEMATICS AND INFORMATICS**

---

(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):**

#### **SPACE MISSION AND SYSTEM DESIGN**

---

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

## 1. THE GOAL OF MASTERING THE DISCIPLINE

The course "Applied Mechanics and Engineering" is part of the Master's program "Space mission and system design" in the major 01.04.02 "Applied Mathematics and Informatics" and is studied in the first semester of the first year. The course is offered by the Department of Mechanics and Control Processes. It consists of four sections and 18 topics and focuses on the fundamental principles of force, equilibrium, center of gravity, and friction, as well as simple lifting machines; analysis of the main methods for solving typical problems; and familiarization with their application in professional activities.

The goal of mastering the discipline is the formation of fundamental knowledge and skills in the application of problem solving methods necessary for professional activities, increasing the general level of literacy of students in the discipline Applied Mechanics and Engineering. The students will learn how to apply mechanics principles and theories into advanced research and development applications.

## 2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Applied Mechanics and Engineering" 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)*

<b>Cipher</b>	<b>Competence</b>	<b>Indicators of Competency Achievement (within this discipline)</b>
UC-2	Capable of managing a project at all stages of its life cycle	UC-2.1 Formulates a problem, the solution of which is directly related to the achievement of the project goal, defines the connections between the tasks set; UC-2.2 Within the framework of the assigned tasks, determines the available resources and limitations, current legal norms, and optimizes the ways of solving problems; UC-2.3 Monitors the progress of the project, adjusts the schedule in accordance with the monitoring results.
PC-1	Able to formulate goals and objectives of scientific research in the field of applied mathematics and computer science, computer technology and modern programming technologies, and select methods and means for solving problems	PC-1.1 Possesses fundamental knowledge obtained in the field of mathematical and (or) natural sciences, programming and information technology; PC-1.2 Able to find, formulate and solve standard problems in his own research activities in the field of applied mathematics and computer science, computer technology and modern programming technologies; PC-1.3 Has practical experience in research activities in the field of applied mathematics and computer science, computer engineering and modern programming technologies.;
PC-3	Capable of participating in scientific research and development of design solutions in the field of ballistics, dynamics and flight control of spacecraft	PC-3.1 Knows the basic mathematical methods and modern tools in the field of ballistic design of space complexes and systems; PC-3.2 Possesses basic knowledge of standards, norms and rules for developing design solutions in the field of ballistics, dynamics and flight control of spacecraft; PC-3.3 Able to apply mathematical methods and modern information technologies in conducting scientific research and developing design solutions in the field of ballistics, dynamics and flight control of spacecraft.
PC-5	Capable of analyzing, including in English, methods for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories	PC-5.1 Knows proven and applied methods, including those from English-language sources, for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories; PC-5.2 Able to develop and modernize methods for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories;

<b>Cipher</b>	<b>Competence</b>	<b>Indicators of Competency Achievement (within this discipline)</b>
		PC-5.3 Has mastered methods and approaches to studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories.

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

Discipline "Applied Mechanics and Design of Engineering Systems" refers to the part formed by the participants of educational relations 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 "Applied Mechanics and Design of Engineering Systems".

*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*

<b>Cipher</b>	<b>Name of competence</b>	<b>Previous courses/modules, practical training*</b>	<b>Subsequent disciplines/modules, practices*</b>
UC-2	Capable of managing a project at all stages of its life cycle		Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research; Pre-Graduation Internship in Industry; Aerospace Systems; System Design; Dynamics and Control of Space Systems; Project "Drone Systems Engineering. Part 1"; Project "Drone Systems Engineering. Part 2";
PC-1	Able to formulate goals and objectives of scientific research in the field of applied mathematics and computer science, computer technology and modern programming technologies, and select methods and means for solving problems		Pre-Graduation Internship in Industry; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) / Research work; Technological Training; Advanced Methods of Remote Sensing and Geoinformation Systems; System Design; Dynamics and Control of Space Systems;

Cipher	Name of competence	Previous courses/modules, practical training*	Subsequent disciplines/modules, practices*
PC-3	Capable of participating in scientific research and development of design solutions in the field of ballistics, dynamics and flight control of spacecraft		Pre-Graduation Internship in Industry; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) / Research work; Technological Training; Aerospace Systems; Structures & Materials Modeling; System Design; On-board Energy; Dynamics and Control of Space Systems; Project "Drone Systems Engineering. Part 1"; Project "Drone Systems Engineering. Part 2";
PC-5	Capable of analyzing, including in English, methods for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories		Pre-Graduation Internship in Industry; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) / Research work; Technological Training; Aerospace Systems; Structures & Materials Modeling; System Design; On-board Energy; Dynamics and Control of Space Systems; Advanced Methods of Remote Sensing and Geoinformation Systems;

\* - 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 “Applied Mechanics and Design of Engineering Systems” is 6 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)
			1
<i>Contact work, academic hours</i>	20		20
Lectures (LC)	10		10
Laboratory work (LW)	0		0
Practical/seminar classes (SC)	10		10
<i>Independent work of students, academic hours</i>	160		160
<i>Control (exam/test with assessment), academic hours</i>	36		36
<b>Total complexity of the discipline</b>	<b>academic hours</b>	<b>216</b>	<b>216</b>
	<b>credit</b>	<b>6</b>	<b>6</b>

## 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	Force	1.1	Fundamentals	Introduction to the concept of force. Definition of force as an interaction that causes or tends to cause a change in motion or deformation. Vector nature of force: magnitude, direction, and point of application. Scalar and vector quantities in mechanics.	LC, SC
		1.2	Force	Characteristics of force. Classification of forces: contact forces and body forces. Examples of gravitational, electromagnetic, and contact forces. Units of force measurement.	LC, SC
		1.3	Resolution of a force	Decomposition of a force into components along specified directions. Rectangular components. Non-rectangular components. Practical applications of force resolution in engineering problems.	LC, SC
		1.4	Moment of a force	Definition of the moment of a force about a point and about an axis. Physical meaning of moment as a measure of rotational effect. Calculation of moment arm. Sign conventions: clockwise and counterclockwise moments. Varignon's theorem for moments of concurrent forces.	LC, SC
		1.5	Force system	Classification of force systems: coplanar and non-coplanar, concurrent and non-concurrent, parallel and general force systems. Resultant of a force system. Simplification of force systems.	LC, SC
		1.6	Composition of Forces	Determination of the resultant of multiple forces acting on a body. Methods of composition: parallelogram law, triangle law, and polygon law. Graphical and analytical approaches.	LC, SC
Section 2	Equilibrium	2.1	Definition, conditions of equilibrium	Definition of a body in equilibrium as a state of zero net force and zero net moment. Translational equilibrium: sum of all forces equals zero. Rotational equilibrium: sum of all moments equals zero. Necessary and sufficient conditions for equilibrium in two and three dimensions.	LC, SC
		2.2	Lami's Theorem	Statement of Lami's theorem for three concurrent, coplanar, and non-collinear forces in equilibrium. Conditions for application of the theorem. Relationship between forces and sines of opposite angles. Practical examples and problem-solving techniques.	LC, SC
		2.3	Equilibrant	Definition of the equilibrant force as a single force that brings a force system into equilibrium. Relationship between the resultant and the equilibrant: equal in magnitude, opposite in direction, and	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				collinear in action. Determination of the equilibrant in various force systems.	
		2.4	Beams	Introduction to beams as structural elements. Types of beams: simply supported beams, cantilever beams, overhanging beams, fixed beams. Types of loads: point loads, uniformly distributed loads, uniformly varying loads. Support reactions and their determination using equilibrium conditions. Shear force and bending moment concepts.	LC, SC
Section 3	Center of Gravity and Friction	3.1	Centroid	Definition of centroid as the geometric center of a plane figure or a solid body. Centroid of standard shapes: rectangle, triangle, circle, semicircle. Determination of centroids of composite bodies using the method of moments. Importance of centroid location in engineering design.	LC, SC
		3.2	Center of gravity	Definition of center of gravity as the point where the entire weight of a body is assumed to act. Distinction between centroid as a geometric property and center of gravity as a gravitational property. Methods for locating the center of gravity of irregular and composite bodies. Relationship between center of gravity and stability.	LC, SC
		3.3	Definition of friction, force of friction	Introduction to friction as a force resisting relative motion between surfaces in contact. Classification of friction: static friction, kinetic or dynamic friction, rolling friction. The force of friction: magnitude, direction, and dependence on normal reaction. Laws of dry or Coulomb friction. Coefficient of friction and angle of friction.	LC, SC
		3.4	Equilibrium of bodies on level plane	Analysis of bodies at rest or in impending motion on a horizontal surface. Calculation of limiting friction. Conditions for sliding versus tipping. Relationship between applied force, normal reaction, and frictional force. Practical examples: objects on horizontal surfaces, braking systems.	LC, SC
		3.5	Equilibrium of bodies on inclined plane	Resolution of forces on an inclined plane: components parallel and perpendicular to the plane. Conditions for a body to slide down, remain at rest, or be on the point of motion on an incline. Role of friction on inclined surfaces. Angle of repose as the angle at which sliding begins. Practical examples: ramps, wedge problems, conveyor belts.	LC, SC
Section 4	Simple Lifting Machine	4.1	Definitions of simple machine	Definition of a simple lifting machine as a mechanical device used	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				to overcome a larger load by applying a smaller effort. Core terminology: effort as the applied force, load as the weight to be lifted. Mechanical advantage as the ratio of load to effort. Velocity ratio as the ratio of distance moved by effort to distance moved by load. Input work, output work, and efficiency of a machine.	
		4.2	Law of machine, maximum mechanical advantage	The law of machine as a linear relationship between effort and load. Graphical representation: effort versus load plot. Determination of maximum mechanical advantage as the limiting value when effort approaches zero. Limiting efficiency of a machine. Reversible and self-locking or non-reversible machines. Conditions for maximum efficiency.	LC, SC
		4.3	Study of simple machines	Detailed analysis of common lifting machines: lever systems of first, second, and third order. Pulley systems: single fixed pulley, single movable pulley, block and tackle. Screw jack: principle of operation and applications. Wheel and axle. Inclined plane as a lifting machine. Calculation of mechanical advantage, velocity ratio, and efficiency for each type. Practical applications in construction, transportation, and material handling. Comparative evaluation of different simple machines.	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.	
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.	
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.	

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

## 7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

### Main literature:

1. "Vector Mechanics for Engineers: Statics and Dynamics," by Beer, Johnston, and Eisenberg, McGraw-Hill, 10th Edition.
2. "Materials Science and Engineering", William D. Callister Jr. and David G. Rethwisch, 9th ed., SI Version, John Wiley & Sons, 2014
3. "Shigley's Mechanical Engineering Design", Richard G Budynas and Keith J Nisbett, 10th ed., McGraw-Hill Higher Education, 2014

### Further reading:

1. "Elasticity", James R. Barber, 3rd ed., Dordrecht: Springer Netherlands, 2010. On-line version available through CityU library.
2. "Mechanics of materials," Barry J. Goodno and James M. Gere, 9th ed., SI Version, Cengage Learning, 2018.

### 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
  - RUDN University Electronic Library System – RUDN University Electronic Library System <https://mega.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](http://www.studentlibrary.ru)
  - EBS "Knowledge" <https://znanium.ru/>
2. Databases and search engines
  - Sage <https://journals.sagepub.com/>

- Springer Nature Link <https://link.springer.com/>
- Wiley Journal Database <https://onlinelibrary.wiley.com/>
- Scientometric database Lens.org <https://www.lens.org>

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

1. Lecture course on the subject "Applied Mechanics and Design of Engineering Systems".

\* - 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:**

Associate Professor

*Position, DEPARTMENT*

*Signature*

Saltykova Olga  
Alexandrovna

*Surname I.O.*

**HEAD OF THE DEPARTMENT:**

Head of Department

*Position of the DEPARTMENT*

*Signature*

Razumny Yuri Nikolaevich

*Surname I.O.*

**HEAD OF THE EP HE:**

Professor

*Position, DEPARTMENT*

*Signature*

Razumny Yuri Nikolaevich

*Surname I.O.*