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

AEROSPACE SYSTEMS

(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)

2026

1. THE GOAL OF MASTERING THE DISCIPLINE

The "Aerospace Systems" course is part of the "Space mission and system design" master's program in the "Applied Mathematics and Informatics" major (01.04.02) and is studied in the second semester of the first year. The course is offered by the department of the partner university. It consists of four sections and 18 topics and focuses on the fundamental principles of aeronautics, aerospace operations, human factors, safety management, and systems thinking, enabling them to solve real-world aerospace problems using the problem-solving process in Aerospace Systems. It establishes a basis for further education and employment in the fields of aviation management, flight operations, engineering, and aerospace technical disciplines.

The goal of mastering this course is to develop fundamental knowledge and skills in applying problem-solving methods necessary for professional work, to increase students' overall literacy in aerospace systems through their problem-solving learning experiences, and to improve their ability to interpret events, analyze situations, and comprehend cause-and-effect relationships. Students recognize the complexity of global, national, and local community problem situations and understand the challenges faced in generating sustainable and durable solutions.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Aerospace Systems" 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)
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.
GPC-2	Capable of improving and implementing new mathematical methods for solving applied problems	GPC-2.1 Uses the results of applied mathematics to master and adapt new methods for solving problems in the area of professional interests; GPC-2.2 Implements and improves new methods for solving applied problems in the field of professional activity; GPC-2.3 Conducts a qualitative and quantitative analysis of the obtained solution in order to construct an optimal option.
GPC-3	Able to develop mathematical models and analyze them when solving problems in the field of professional activity	GPC-3.1 Develops mathematical models in the field of applied mathematics and computer science; GPC-3.2 Analyzes mathematical models for solving applied problems of professional activity; GPC-3.3 Develops and analyzes new mathematical models for solving applied problems of professional activity in the field of applied mathematics and computer science.
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

Cipher	Competence	Indicators of Competency Achievement (within this discipline)
		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; 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 "Aerospace Systems" 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 "Aerospace 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

Cipher	Name of competence	Previous courses/modules, practical training*	Subsequent disciplines/modules, practices*
UC-2	Capable of managing a project at all stages of its life cycle	*Applied Mechanics and Engineering***; *Systems Engineering***;	Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research; Pre-Graduation Internship in Industry; System Design; Dynamics and Control of Space Systems; Project "Drone Systems Engineering. Part 2";
GPC-2	Capable of improving and implementing new mathematical methods for solving applied problems		Pre-Graduation Internship in Industry; Technological Training; System Design; On-board Energy; Dynamics and Control of Space Systems;
GPC-3	Able to develop mathematical models and analyze them when solving problems in the field of professional activity	*Programming;*	System Design; On-board Energy; Dynamics and Control of Space Systems; Project "Drone Systems Engineering. Part 2"; Pre-Graduation Internship in Industry; Technological Training;

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	*Applied Mechanics and Engineering**;* *Systems Engineering**;*	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; System Design; On-board Energy; Dynamics and Control of Space Systems; 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	*English Language;* *Applied Mechanics and Engineering**;* *Systems Engineering**;* *Russian as a Foreign Language;*	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; System Design; On-board Energy; Dynamics and Control of Space 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 “Aerospace Systems” discipline is 5 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)**
			2
Contact work, academic hours	*90*		*90*
Lectures (LC)	36		36
Laboratory work (LW)	18		18
Practical/seminar classes (SC)	36		36
Independent work of students, academic hours	*54*		*54*
Control (exam/test with assessment), academic hours	*36*		*36*
Total complexity of the discipline	**academic hours**	***180***	*180*
	credit	***5***	*5*

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	Fundamentals of Flight	1.1	Aerodynamics and mechanics of flight	Basic principles of aerodynamics as applied to flight. Forces acting on an aircraft in flight: lift, weight, thrust, drag. Airflow patterns around airfoils and bodies. Pressure distribution and boundary layer concepts. Newton's laws of motion applied to aircraft flight.	LC, LW, SC
		1.2	Properties of the atmosphere	Physical properties of the Earth's atmosphere: pressure, temperature, density, humidity. Variation of properties with altitude. The International Standard Atmosphere model as a reference for flight calculations. Atmospheric effects on aircraft performance and handling.	LC, LW, SC
		1.3	Development of aerodynamic forces	Generation of lift: Bernoulli's principle, circulation, angle of attack. Lift coefficient and factors affecting lift: airspeed, air density, wing area, airfoil shape. Generation of drag: parasite drag including form drag and skin friction drag, induced drag. Drag polar diagrams. Lift-to-drag ratio and its importance for flight efficiency.	LC, LW, SC
		1.4	Basics of aircraft performance	Performance parameters: takeoff distance, climb rate, cruise speed, range, endurance, landing distance. Factors affecting performance: weight, altitude, temperature, wind. Thrust-to-weight ratio and wing loading. Performance calculations for different flight phases.	LC, LW, SC
		1.5	Stability and control	Static stability: positive, neutral, negative. Dynamic stability: convergence or divergence of oscillations. Longitudinal stability: pitch stability contributions from wing and tail. Lateral stability: roll stability or dihedral effect. Directional stability: yaw stability or weathercock stability. Control surfaces: elevator for pitch, aileron for roll, rudder for yaw. Trim systems and control harmony.	LC, LW, SC
		1.6	Fundamentals of high speed flight	Subsonic, transonic, supersonic, and hypersonic flight regimes. Compressibility effects: shock waves, expansion waves. Wave drag and its mitigation through wing sweep. Critical Mach number and drag divergence Mach number. Area rule for transonic aircraft design. Changes in aerodynamic center and control effectiveness at high speeds.	LC, LW, SC
		1.7	Rotary wing flight	Principles of rotorcraft flight: helicopters, autogyros, tiltrotors. Rotor systems: main rotor and tail rotor configurations. Generation of lift and thrust by rotating blades. Hovering, vertical takeoff and	LC, LW, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				landing, forward flight, autorotation. Cyclic and collective pitch control. Torque reaction and anti-torque systems.	
Section 2	Aircraft Electrical Systems	2.1	Operating principles and applications of the electrical systems	Basic principles of electrical power generation, distribution, and utilization in aircraft. Direct current and alternating current systems. Voltage levels and frequency standards. Applications: flight instruments, avionics, lighting, actuation, environmental control, ice protection.	LC, LW, SC
		2.2	Equipment used for the electric generation	Engine-driven generators: direct current generators, alternating current generators. Constant speed drives and integrated drive generators. Variable frequency generators. Starter-generators. Auxiliary power unit generators. Emergency generators: ram air turbines, hydraulically driven generators. Batteries as backup power sources.	LC, LW, SC
		2.3	Distribution and utilization of electrical power required for aircraft operations	Electrical power distribution architectures: bus bars, contactors, relays, circuit breakers. Primary distribution, secondary distribution, and essential power buses. Load shedding and power management systems. Utilization equipment: electric motors, actuators, heating elements, lighting systems, avionics suites.	LC, LW, SC
		2.4	Construction and operation of turbine engines	Gas turbine engine types: turbojet, turbofan, turboprop, turboshaft. Major components: air inlet, compressor, combustion chamber, turbine, exhaust nozzle, accessories gearbox. Compressor types: axial flow, centrifugal flow, mixed flow. Combustor designs: can, annular, can-annular. Turbine stages: high pressure turbine, low pressure turbine, free turbine. Starting, ignition, and steady-state operation.	LC, LW, SC
Section 3	Aerospace Operation and Practices	3.1	Industry practices in aircraft operation and maintenance	Standard operating procedures for commercial and general aviation. Daily and pre-flight inspections. Scheduled and unscheduled maintenance. Line maintenance, base maintenance, heavy maintenance checks. Turnaround procedures between flights. Ground handling operations and refueling. Maintenance documentation and record keeping.	LC, LW, SC
		3.2	Handling and usage of aircraft maintenance tools	Common hand tools used in aircraft maintenance: wrenches, sockets, screwdrivers, pliers, hammers, chisels. Specialized tools: torque wrenches, rivet guns, cable tension meters, borescopes. Precision measuring instruments: micrometers, calipers, dial indicators, feeler gauges. Tool control procedures and foreign object	LC, LW, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				debris prevention. Safe usage practices and tool calibration requirements.	
		3.3	Quality management system, safety precaution requirements	Quality management principles in aerospace: ISO 9001, AS9100 standards. Quality assurance versus quality control. Maintenance error prevention and human factors. Safety management systems. Personal protective equipment requirements. Hazardous material handling and storage. Fire safety, electrical safety, fuel system safety. Confined space entry and working at height procedures.	LC, LW, SC
		3.4	Interpretation of schematic diagrams for aircraft equipment installation	Reading and understanding electrical schematic diagrams. Hydraulic and pneumatic system schematics. Fuel system diagrams and environmental control system diagrams. Wiring diagrams and interconnection diagrams. Installation drawings and assembly drawings. Symbol recognition and legend interpretation. Troubleshooting using schematics.	LC, LW, SC
Section 4	Introduction to Operations Management	4.1	Operations strategy	Definition of operations management in aerospace context. Strategic role of operations in achieving organizational goals. Competitive priorities: cost, quality, time, flexibility. Alignment between operations strategy and business strategy. Capacity planning and strategic outsourcing.	LC, LW, SC
		4.2	Design of operations processes	Process types: project processes, job shop processes, batch processes, assembly line processes, continuous flow processes. Process mapping and flow charting. Facility layout types: fixed-position layout, process-oriented layout, cell layout, product-oriented layout. Process selection criteria based on volume and variety. Technology selection and automation decisions.	LC, LW, SC
		4.3	Operations Management	Production planning and scheduling. Inventory management: raw materials, work-in-progress, finished goods. Material requirements planning and enterprise resource planning systems. Supply chain management in aerospace: supplier selection, procurement, logistics. Quality control and continuous improvement methodologies: Lean, Six Sigma, Total Quality Management. Performance measurement: key performance indicators, balanced scorecard. Maintenance management and reliability-centered maintenance.	LC, LW, 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.	
Laboratory	A classroom for laboratory work, individual consultations, ongoing monitoring and midterm assessment, equipped with a set of specialized furniture and equipment.	
Computer class	A computer room for conducting classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with personal computers (in the amount of ____ units), a board (screen) and technical means for multimedia presentations.	
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. Orbital Mechanics for Engineering Students (Aerospace Engineering) 4th Edition—by Howard D. Curtis Ph.D. Purdue University
2. Introduction to Aerospace Engineering with a Flight Test Perspective (Aerospace Series) 1st Edition—by Stephen Corda
3. Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems 3rd Edition—by Brian L. Stevens, Frank L. Lewis, Eric N. Johnson
4. Missile Design and System Engineering (AIAA Education)—by Eugene L. Fleeman

Further reading:

1. Rocket Propulsion Elements 9th Edition—by George P. Sutton, Oscar Biblarz
2. Aircraft Structures (Dover Books on Aeronautical Engineering)—by David J. Peery

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
- 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 "Aerospace 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!

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