

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

SYSTEM DESIGN

(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 "Systems Design" 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 third semester of the second year. The course is offered by the department of the partner university. It consists of 10 sections and 26 topics and focuses on the fundamental principles of key aircraft systems, including flight control systems, fuel systems, propulsion systems, hydraulic systems, electrical systems, avionics systems, environmental control systems, pneumatic systems, and emergency systems, as well as the relationships among major aviation systems, air traffic management, flight standards, airworthiness provided by regulatory bodies, and accident investigation.

The purpose of mastering the discipline is to develop fundamental knowledge and skills in applying problem-solving methods necessary for professional activity, to increase the general level of literacy of students in the discipline of System Design, to develop students' knowledge on the components and operating principles of essential mechanical, electrical and avionics systems in civil transport aircraft, to provide students with an overview of the components of aviation systems, to develop students' appreciation towards academic integrity.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Systems Design" 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-1	Capable of carrying out a critical analysis of problematic situations based on a systems approach and developing an action strategy	UC-1.1 Analyzes the task, identifying its basic components; UC-1.2 Searches for information to solve a given problem using various types of queries, suggests options for solving the problem, and analyzes the possible consequences of their use; UC-1.3 Analyzes ways of solving problems of ideological, moral and personal nature based on the use of basic philosophical ideas and categories in their historical development and socio-cultural context.
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

Cipher	Competence	Indicators of Competency Achievement (within this discipline)
		applied mathematics and computer science.
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-2	Able to apply modern theoretical and experimental methods for developing mathematical models of objects and processes under study related to professional activities in the field of training and participate in their implementation in the form of software products	PC-2.1 Knows modern theoretical and experimental methods for developing mathematical models, innovative design tools and elements of architectural solutions for information systems; PC-2.2 Able to develop and implement algorithms for mathematical models based on languages and packages of applied modeling programs; PC-2.3 Has practical experience in developing options for implementing information systems using innovative tools.
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; 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 "Systems Design" 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 "Systems Design".

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	Aerospace Systems; Project "Drone Systems Engineering. Part 1";	Pre-Graduation Internship in Industry; Dynamics and Control of

Cipher	Name of competence	Previous courses/modules, practical training*	Subsequent disciplines/modules, practices*
		<i>Applied Mechanics and Engineering**</i> ; <i>Systems Engineering**</i> ; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research;	Space Systems;
UC-1	Capable of carrying out a critical analysis of problematic situations based on a systems approach and developing an action strategy	Databases; Advanced Methods of Remote Sensing and Geoinformation Systems; Structures & Materials Modeling; Project "Drone Systems Engineering. Part 1"; <i>Machine Learning and Big Data Mining**</i> ; <i>From Data Acquisition to Data Treatment**</i> ; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research;	Dynamics and Control of Space Systems; Technological Training; Pre-Graduation Internship in Industry;
GPC-2	Capable of improving and implementing new mathematical methods for solving applied problems	Aerospace Systems; Structures & Materials Modeling;	Pre-Graduation Internship in Industry; Technological Training; 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; Aerospace Systems; Structures & Materials Modeling; Project "Drone Systems Engineering. Part 1";	Dynamics and Control of Space Systems; Pre-Graduation Internship in Industry; Technological Training;
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	Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research; Programming; Databases; Advanced Methods of Remote Sensing and Geoinformation Systems; <i>Machine Learning and Big Data Mining**</i> ; <i>From Data Acquisition to Data Treatment**</i> ; <i>Applied Mechanics and Engineering**</i> ; <i>Systems Engineering**</i> ; <i>Virtual Reality and Computer Vision**</i> ; <i>Modeling and Validation**</i> ;	Pre-Graduation Internship in Industry; Technological Training; Dynamics and Control of Space Systems;

Cipher	Name of competence	Previous courses/modules, practical training*	Subsequent disciplines/modules, practices*
PC-2	Able to apply modern theoretical and experimental methods for developing mathematical models of objects and processes under study related to professional activities in the field of training and participate in their implementation in the form of software products	Programming; Databases; Advanced Methods of Remote Sensing and Geoinformation Systems; Project "Drone Systems Engineering. Part 1"; <i>Machine Learning and Big Data Mining</i> **; <i>From Data Acquisition to Data Treatment</i> **; <i>Virtual Reality and Computer Vision</i> **; <i>Modeling and Validation</i> **; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research;	Pre-Graduation Internship in Industry; Technological Training;
PC-3	Capable of participating in scientific research and development of design solutions in the field of ballistics, dynamics and flight control of spacecraft	Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research; Aerospace Systems; Structures & Materials Modeling; Project "Drone Systems Engineering. Part 1"; <i>Applied Mechanics and Engineering</i> **; <i>Systems Engineering</i> **;	Pre-Graduation Internship in Industry; Technological Training; Dynamics and Control of Space Systems;
PC-5	Capable of analyzing, including in English, methods for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories	English Language; Aerospace Systems; Structures & Materials Modeling; <i>Applied Mechanics and Engineering</i> **; <i>Systems Engineering</i> **; Russian as a Foreign Language; Advanced Methods of Remote Sensing and Geoinformation Systems; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research;	Pre-Graduation Internship in Industry; Technological Training; 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 discipline “System Design” 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)
			3
<i>Contact work, academic hours</i>	72		72
Lectures (LC)	36		36
Laboratory work (LW)	0		0
Practical/seminar classes (SC)	36		36
<i>Independent work of students, academic hours</i>	72		72
<i>Control (exam/test with assessment), academic hours</i>	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	Atmospheric Condition	1.1	Properties of air	Basic physical properties of air: density, pressure, temperature, viscosity, humidity. Relationships between properties and their variation with altitude. Impact of air properties on aircraft performance and system design.	LC, SC
		1.2	The Earth's atmosphere	Structure of the atmosphere: troposphere, stratosphere, mesosphere, thermosphere, exosphere. Characteristics and boundaries of each layer. Atmospheric phenomena affecting flight operations.	LC, SC
		1.3	Standard atmosphere	Definition and purpose of the International Standard Atmosphere model. Assumptions and reference values: sea level pressure, temperature, density, lapse rates. Use of standard atmosphere for aircraft performance calculations and system calibration.	LC, SC
		1.4	Atmospheric wind and turbulence	Wind patterns: global circulation, jet streams, local winds. Wind shear and its effects on flight. Turbulence: causes, types, and intensity measurement. Impact on aircraft handling, structural loads, and system design considerations.	LC, SC
Section 2	Flight Control Systems	2.1	Principles of flight control	Basic principles of aircraft control around three axes: pitch, roll, yaw. Aerodynamic forces and moments generated by control surfaces. Stability and controllability concepts. Manual and automated control modes.	LC, SC
		2.2	Primary and secondary flight controls	Primary flight controls: ailerons for roll control, elevators for pitch control, rudder for yaw control. Secondary flight controls: flaps, slats, spoilers, trim systems, high-lift devices. Functions, actuation mechanisms, and integration with flight control computers.	LC, SC
Section 3	Hydraulic Systems and Pneumatic Systems	3.1	Hydraulic systems in aircraft and their applications.	Principles of hydraulic power transmission. Main components: pumps, reservoirs, accumulators, valves, actuators, filters. Hydraulic fluid properties and selection criteria. Applications: flight control actuation, landing gear extension and retraction, braking systems, cargo door operation.	LC, SC
		3.2	Landing-gear system. Braking and anti-skid	Landing gear system components: struts, wheels, brakes, retraction mechanisms, position indicators. Braking system types and operation. Anti-skid systems: purpose, sensors, control logic for preventing wheel lockup during braking.	LC, SC
		3.3	Use of bleed air. Bleed air control	Bleed air extraction from engine compressors. Applications: cabin	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				pressurization, air conditioning, de-icing and anti-icing systems, pneumatic actuators. Bleed air control valves, regulation, temperature control, and distribution manifold.	
		3.4	Thrust reversers	Purpose of thrust reversers for deceleration after landing. Types: cascade type, clamshell type, cold stream and hot stream reversers. Operating principles, deployment mechanisms, and integration with engine and brake systems. Safety interlocks and operational considerations.	LC, SC
Section 4	Electrical Systems	4.1	Civil aircraft electrical system	Overview of aircraft electrical system architecture. Power sources: generators, alternators, batteries, auxiliary power units. Power distribution: bus bars, circuit breakers, relays, contactors. Voltage regulation and protection devices.	LC, SC
		4.2	Electrical power generation	Engine-driven generators: alternating current and direct current generation. Constant speed drives and variable frequency generators. Backup power sources: batteries, ram air turbines, emergency generators. Power quality parameters: voltage, frequency, waveform.	LC, SC
		4.3	Motors and Actuators. Electrical loads	Types of electric motors used in aircraft: direct current motors, alternating current motors, stepper motors. Linear and rotary actuators for flight controls, landing gear, valves. Classification of electrical loads: continuous, intermittent, essential, non-essential. Load analysis and power budgeting.	LC, SC
Section 5	Avionics Systems	5.1	Regulatory and Advisory Agencies related to avionics systems	International and national regulatory bodies: International Civil Aviation Organization, Federal Aviation Administration, European Union Aviation Safety Agency. Advisory organizations: Radio Technical Commission for Aeronautics, ARINC. Their roles in standards, certification, and guidance for avionics equipment.	LC, SC
		5.2	Fundamentals of airborne communication systems	Voice communication systems: very high frequency and high frequency radios, selective calling, satellite communication. Data communication systems: aircraft communications addressing and reporting system, controller-pilot data link communications. Antenna systems and signal propagation.	LC, SC
		5.3	Basic principles of terrestrial radio navigation and landing aids	Navigation principles: bearing, distance, position fixing using radio signals. Systems: very high frequency omnidirectional range, distance measuring equipment, automatic direction finder, instrument landing system, microwave landing system. Approach and	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				landing procedures using navigation aids.	
Section 6	Environmental Control Systems	6.1	Environmental control system design	Objectives: maintaining a comfortable and safe cabin environment. System architecture: bleed air supply, air conditioning packs, distribution ducting, recirculation fans. Design considerations: heat loads, altitude compensation, flow rates, redundancy.	LC, SC
		6.2	Lighting, Air conditioning	Lightning protection: conductive paths, surge protection, bonding. Air conditioning system components: heat exchangers, air cycle machines, ram air systems, vapor cycle systems. Temperature control: mixing valves, zone control valves, temperature sensors.	LC, SC
		6.3	Cabin pressurization	Need for cabin pressurization at high altitudes. Pressure schedule and cabin altitude limits. Pressurization system components: out-flow valves, pressure controllers, safety valves, positive pressure relief. Pressurization modes: isobaric and constant differential. Emergency depressurization procedures.	LC, SC
Section 7	Land Gear Systems	7.1	Aircraft landing gear, gear arrangement	Landing gear configurations: tricycle gear, tailwheel gear, tandem gear. Nose gear and main gear arrangements. Gear types: fixed gear versus retractable gear. Shock absorbing mechanisms: oleo-pneumatic struts, spring struts, torsion links.	LC, SC
		7.2	Retraction and detraction, structures and tires	Retraction and extension mechanisms: hydraulic actuation, mechanical linkages, locking mechanisms. Gear position indication and warning systems. Landing gear structure: materials, stress analysis, fatigue life. Tire types: bias ply, radial ply. Tire construction, inflation pressure, wear limits, and inspection criteria.	LC, SC
Section 8	Emergency Systems	8.1	Emergency power generation. Battery system	Emergency power sources: ram air turbines, emergency generators, dedicated batteries. Automatic deployment and activation logic. Emergency power distribution and load shedding. Aircraft battery systems: lead-acid, nickel-cadmium, lithium-ion. Charging, monitoring, thermal management.	LC, SC
		8.2	Warning systems. Fire detection and suppression	Warning system types: master caution, master warning, aural warnings, voice alerts. Engine and auxiliary power unit fire detection: thermal switches, optical detectors, gas detectors. Fire suppression systems: fire extinguisher bottles, discharge tubes, distribution networks. Cabin fire detection and suppression. Smoke detection and evacuation systems.	LC, SC
Section 9	Aviation Systems	9.1	Key aviation system components. Relationship among various components	Major aircraft systems: airframe, propulsion, avionics, electrical, hydraulic, pneumatic, environmental control, fuel, landing gear.	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				Functional relationships and interdependencies. System integration principles. Effects of one system failure on other systems.	
		9.2	Flight planning. Flight simulator. Airport operation. Airline management	Flight planning process: route selection, fuel calculation, weight and balance, weather briefing, NOTAM review. Flight simulators: types, certification levels, use in pilot training and system development. Airport operations: airside and landside operations, ground handling, passenger processing. Airline management: fleet planning, crew scheduling, operations control, maintenance planning, safety management systems.	LC, SC
Section 10	Air Traffic Control	10.1	Radar fundamentals & basic surveillance systems	Principles of radar: pulse transmission, signal reflection, distance measurement, angular position determination. Primary surveillance radar: operation, limitations, target identification. Secondary surveillance radar: transponder interrogation, reply signals, Mode A, Mode C, Mode S. Automatic dependent surveillance-broadcast. Comparison of surveillance technologies. Air traffic control procedures using radar data.	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. Moir and AG Seabridge, Design and Development of Aircraft Systems – An Introduction, First Edition, AIAA Education Series, 2004
2. Jon D. Fricker and Robert K. Whitford, Fundamentals of Transportation Engineering: A Multimodel Systems Approach, Prentice-Hall, 2004
3. Helfrick A, Principles of Avionics, 7th Edition, Avionics Communications, 2012

Further reading:

1. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”, Lockheed Martin Aeronautics Company, 2001
2. Richard De Neufville. Airport Systems: Planning, Design, and Management, McGraw-Hill, 2003

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 "Systems design".

* - 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:

Position of the DEPARTMENT

Signature

Surname I.O.

HEAD OF THE EP HE:

Professor

Position, DEPARTMENT

Signature

Razumny Yuri Nikolaevich

Surname I.O.