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

**Engineering Academy**
(name of the main educational unit (POU) - developer of the EP HE)

# DISCIPLINE WORK PROGRAM

## SYSTEM DESIGN
(name of discipline/module)

**Recommended by MSSN for the following areas of training/specialty:**

## 01.04.02 APPLIED MATHEMATICS AND INFORMATION SCIENCE
(code and name of the area of training/specialty)

**The discipline is mastered as part of the implementation of the main professional educational program of higher education (OP HE):**

## BALLISTIC DESIGN OF SPACE COMPLEXES AND SYSTEMS
(name (profile/specialization) EP HE)

**2024G.**

## 1. GOAL OF DISCIPLINE MASTERING

The discipline "System Design" is included in the master's program "Ballistic design of space complexes and systems" in the direction of 01.04.02 "Applied mathematics and computer science" and is studied in the 3rd semester of the 2nd year. The discipline is implemented by the Department of the Partner University. The discipline consists of 10 sections and 26 topics and is aimed at studying the fundamental principles of key aircraft systems including flight control system, fuel system, propulsion system, hydraulic system, electrical systems, avionics system, environmental control system, pneumatic system, and emergency system, the relationship 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 activities, to increase the overall level of students' literacy in the System Design discipline, to develop students' knowledge on the components and operating principles of essential mechanical, electrical and avionics systems in civil transport aircraft, to provide students 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 "System Design" is aimed at developing the following competencies (parts of competencies) in students:

*Table 2.1. List of competencies formed in students when mastering the discipline (results of mastering the discipline)*

| Cipher | Competence | Indicators of Competency Achievement (within this discipline) |
|---|---|---|
| UK-1 | Able to critically analyze problem situations based on a systematic approach and develop an action strategy | UK-1.1 Analyzes the task, highlighting its basic components;;<br>UK-1.2 Identifies and ranks the information required to solve the task;;<br>UK-1.3 Searches for information to solve a given problem using various types of requests;;<br>UK-1.4 Offers options for solving a problem, analyzes the possible consequences of their use;; |
| UK-2 | Able to manage a project at all stages of its life cycle | UK-2.1 Formulates a problem, the solution of which is directly related to achieving the project goal;;<br>UK-2.2 Determines the connections between the assigned tasks and the expected results of their solution;;<br>UK-2.3 Within the framework of the assigned tasks, determines the available resources and limitations, current legal norms;;<br>UK-2.4 Analyzes the project implementation schedule as a whole and selects the optimal way to solve the assigned tasks, based on current legal norms and available resources and limitations;;<br>UK-2.5 Monitors the progress of the project, adjusts the schedule in accordance with the results of control.; |
| OPK-2 | Able to improve and implement 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 field of professional interests;;<br>OPK-2.2 Implements and improves new methods for solving applied problems in the field of professional activity;;<br>OPK-2.3 Conducts qualitative and quantitative analysis of the resulting solution in order to construct the optimal option.; |
| OPK-3 | Able to develop mathematical models and analyze them when solving problems in the field of professional activity | OPK-3.1 Develops mathematical models in the field of applied mathematics and computer science;;<br>OPK-3.2 Analyzes mathematical models for solving applied problems of professional activity;; |

| Cipher | Competence | Indicators of Competency Achievement (within this discipline) |
|---|---|---|
| | | 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-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, select methods and means for solving problems | PC-1.1 Has fundamental knowledge acquired in the field of mathematical and (or) natural sciences, programming and information technology;;<br>PC-1.2 Can find, formulate and solve standard problems in their own research activities in the field of applied mathematics and computer science, computer technology and modern programming technologies;;<br>PC-1.3 Has practical experience in research activities in the field of applied mathematics and computer science, computer technology and modern programming technologies.; |
| PC-2 | Able to apply modern theoretical and experimental methods for developing mathematical models of studied objects and processes 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 of information systems;;<br>PC-2.2 Can develop and implement algorithms for mathematical models based on languages and application packages for modeling;;<br>PC-2.3 Has practical experience in developing options for implementing information systems using innovative tools.; |
| PK-3 | Capable of participating in scientific research and development of design solutions in the field of ballistics, dynamics and spacecraft flight control | PC-3.1 Knows basic mathematical methods and modern tools in the field of ballistic design of space complexes and systems;;<br>PC-3.2 Has basic knowledge of standards, norms and rules for the development of design solutions in the field of ballistics, dynamics and spacecraft flight control;;<br>PC-3.3 Able to apply mathematical methods and modern information technologies when conducting scientific research and developing design solutions in the field of ballistics, dynamics and spacecraft flight control.; |
| PK-5 | Able to analyze, including in English, methods for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories | PC-5.1 Knows proven and applied techniques, including from English-language sources, for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories;;<br>PC-5.2 Able to develop and modernize methods for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories;;<br>PC-5.3 Proficient in methods and approaches to the study of ballistic and dynamic characteristics when modeling spacecraft flight trajectories; |

## 3. PLACE OF DISCIPLINE IN THE STRUCTURE OF HE EP

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

As part of the educational program of higher education, 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 EP HE that contribute to achieving the planned results of mastering the discipline*

| Cipher | Name of competency | Previous disciplines/modules, practices* | Subsequent disciplines/modules, practices* |
|---|---|---|---|
| UK-2 | Able to manage a project at all stages of its life cycle | Practical Training in Receiving Remote Sensing Data from | Pre-Graduation Internship in Industry; |

| Cipher | Name of competency | Previous disciplines/modules, practices* | Subsequent disciplines/modules, practices* |
|---|---|---|---|
| | | Satellites and its Interpretation (online from RUDN Mission Control Center) / Research;<br>Project "Drone Systems Engineering. Part 1";<br>*Applied Mechanics and Engineering***;<br>*Systems Engineering***;<br>Aerospace Systems; | Dynamics and Control of Space Systems; |
| UK-1 | Able to critically analyze problem situations based on a systematic approach and develop an action strategy | *Machine Learning and Big Data Mining***;<br>*From Data Acquisition to Data Treatment***;<br>Cross-Cultural Training;<br>Programming;<br>Databases;<br>Advanced Methods of Remote Sensing and Geoinformation Systems;<br>Structures & Materials Modeling;<br>Project "Drone Systems Engineering. Part 1";<br>Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research; | Technological Training;<br>Pre-Graduation Internship in Industry;<br>Dynamics and Control of Space Systems; |
| OPK-2 | Able to improve and implement new mathematical methods for solving applied problems | *Programming;*<br>*Aerospace Systems;*<br>*Structures & Materials Modeling;* | Dynamics and Control of Space Systems;<br>Pre-Graduation Internship in Industry;<br>Technological Training; |
| OPK-3 | Able to develop mathematical models and analyze them when solving problems in the field of professional activity | *Programming;*<br>*Aerospace Systems;*<br>*Structures & Materials Modeling;*<br>*Project "Drone Systems Engineering. Part 1";* | Pre-Graduation Internship in Industry;<br>Technological Training;<br>Dynamics and Control of Space Systems; |
| 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, 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;*<br>*Programming;*<br>*Databases;*<br>*Advanced Methods of Remote Sensing and Geoinformation Systems;*<br>*Machine Learning and Big Data Mining**;*<br>*From Data Acquisition to Data Treatment**;*<br>*Applied Mechanics and Engineering**;*<br>*Systems Engineering**;*<br>*Virtual Reality and Computer Vision**;* | Pre-Graduation Internship in Industry;<br>Technological Training;<br>Dynamics and Control of Space Systems; |

| Cipher | Name of competency | Previous disciplines/modules, practices* | Subsequent disciplines/modules, practices* |
|---|---|---|---|
| | | *Modeling and Validation**;* | |
| PC-2 | Able to apply modern theoretical and experimental methods for developing mathematical models of studied objects and processes related to professional activities in the field of training and participate in their implementation in the form of software products | *Programming;*<br>*Databases;*<br>*Advanced Methods of Remote Sensing and Geoinformation Systems;*<br>*Project "Drone Systems Engineering. Part 1";*<br>*Machine Learning and Big Data Mining**;*<br>*From Data Acquisition to Data Treatment**;*<br>*Virtual Reality and Computer Vision**;*<br>*Modeling and Validation**;*<br>*Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research;* | Pre-Graduation Internship in Industry;<br>Technological Training; |
| PK-3 | Capable of participating in scientific research and development of design solutions in the field of ballistics, dynamics and spacecraft flight control | *Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research;*<br>*Aerospace Systems;*<br>*Structures & Materials Modeling;*<br>*Project "Drone Systems Engineering. Part 1";*<br>*Applied Mechanics and Engineering**;*<br>*Systems Engineering**;* | Pre-Graduation Internship in Industry;<br>Technological Training;<br>Dynamics and Control of Space Systems; |
| PK-5 | Able to analyze, including in English, methods for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories | *Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Research;*<br>*English Language;*<br>*Aerospace Systems;*<br>*Structures & Materials Modeling;*<br>*Applied Mechanics and Engineering**;*<br>*Systems Engineering**;*<br>*Russian as a Foreign Language;*<br>*Advanced Methods of Remote Sensing and Geoinformation Systems;* | Pre-Graduation Internship in Industry;<br>Technological Training;<br>Dynamics and Control of Space Systems; |

* - to be filled out in accordance with the competency matrix and SUP EP VO

** - elective disciplines/practices

## 4. SCOPE OF DISCIPLINE AND TYPES OF STUDY WORK

The total labor intensity of the "System Design" 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 study.*

| **Type of educational work** | **TOTAL,**ac.ch. | | **Semester(s)** |
|---|---|---|---|
| | | | **3** |
| *Contact work, ac.ch.* | *72* | | *72* |
| Lectures (LK) | 36 | | 36 |
| Laboratory work (LR) | 0 | | 0 |
| Practical/seminar sessions (SZ) | 36 | | 36 |
| *Independent work of students, ac.ch.* | *72* | | *72* |
| *Control (exam/test with assessment), academic degree.* | *36* | | *36* |
| **Total labor intensity of the discipline** | **ac.ch.** | ***180*** | *180* |
| | **credit units** | ***5*** | *5* |

## 5. CONTENT OF DISCIPLINE

Table 5.1. Contents of the discipline (module) by type of academic work

| Section number | Name of the discipline section | Contents of the section (topic) | | Type of educational work* |
|---|---|---|---|---|
| Section 1 | Atmospheric Condition | 1.1 | Properties of air | LC, NW |
| | | 1.2 | The Earth's atmosphere | LC, NW |
| | | 1.3 | Standard atmosphere | LC, NW |
| | | 1.4 | Atmospheric wind and turbulence | LC, NW |
| Section 2 | Flight Control Systems | 2.1 | Principles of flight control | LC, NW |
| | | 2.2 | Primary and secondary flight controls | LC, NW |
| Section 3 | Hydraulic Systems and Pneumatic Systems | 3.1 | Hydraulic systems in aircraft and their applications. | LC, NW |
| | | 3.2 | Landing-gear system. Braking and anti-skid | LC, NW |
| | | 3.3 | Use of bleed air. Bleed air control | LC, NW |
| | | 3.4 | Thrust reversers | LC, NW |
| Section 4 | Electrical Systems | 4.1 | Civil aircraft electrical system | LC, NW |
| | | 4.2 | Electrical power generation | LC, NW |
| | | 4.3 | Motors and Actuators. Electrical loads | LC, NW |
| Section 5 | Avionics Systems | 5.1 | Regulatory and Advisory Agencies related to avionics systems | LC, NW |
| | | 5.2 | Fundamentals of airborne communication systems | LC, NW |
| | | 5.3 | Basic principles of terrestrial radio navigation and landing aids | LC, NW |
| Section 6 | Environmental Control Systems | 6.1 | Environmental control system design | LC, NW |
| | | 6.2 | Lighting, Air conditioning | LC, NW |
| | | 6.3 | Cabin pressurization | LC, NW |
| Section 7 | Land Gear Systems | 7.1 | Aircraft landing gear, gear arrangement | LC, NW |
| | | 7.2 | Retraction and detraction, structures and tires | LC, NW |
| Section 8 | Emergency Systems | 8.1 | Emergency power generation. Battery system | LC, NW |
| | | 8.2 | Warning systems. Fire detection and suppression | LC, NW |
| Section 9 | Aviation Systems | 9.1 | Key aviation system components. Relationship among various components | LC, NW |
| | | 9.2 | Flight planning. Flight simulator. Airport operation. Airline management | LC, NW |
| Section 10 | Air Traffic Control | 10.1 | Radar fundamentals & basic surveillance systems | LC, NW |

* - to be filled out only for full-time education: LC – lectures; LR – laboratory work; SZ – practical/seminar classes.

## 6. MATERIAL AND TECHNICAL SUPPORT OF DISCIPLINE

*Table 6.1. Material and technical support of the discipline*

| Audience type | Auditorium equipment | Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary) |
|---|---|---|
| Lecture | An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations. | |
| Seminar | An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with a set of specialized furniture and technical means for multimedia presentations. | |
| For independent work | An auditorium for independent work by students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to EIOS. | |

* - the audience for independent work of students is MANDATORY!

**7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF DISCIPLINE**

*Main literature:*

1. Moir amd 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

*Additional literature:*

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. EBS of RUDN University and third-party EBS, to which university students have access based on concluded agreements

- Electronic library system of RUDN - EBS RUDN http://lib.rudn.ru/MegaPro/Web
- EBS “University Library Online” http://www.biblioclub.ru
- EBS Yurayt http://www.biblio-online.ru
- EBS “Student Consultant” www.studentlibrary.ru
- EBS “Trinity Bridge”

2. Databases and search engines

- electronic fund of legal and regulatory technical 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 students' independent work when mastering a discipline/module*:*

1. A course of lectures on the discipline "System Design".

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

## 8. ASSESSMENT MATERIALS AND POINT-RATING SYSTEM FOR ASSESSING THE LEVEL OF COMPETENCIES FOR A DISCIPLINE

Evaluation materials and point-rating system* for assessing the level of development of competencies (parts of competencies) based on the results of mastering the discipline"System Design" are presented in the Appendix to this Work Program of the discipline.

* - OM and BRS are formed on the basis of the requirements of the relevant local regulatory act of RUDN University.

**DEVELOPER:**

| | | |
|---|---|---|
| *Position, PBU* | *Signature* | *Last name I.O.* |

**HEAD OF BUP:**

| | | |
|---|---|---|
| *Position PBU* | *Signature* | *Last name I.O.* |

**HEAD OF OP VO:**

| | | |
|---|---|---|
| *Position, PBU* | *Signature* | Razumny Yuri Nikolaevich<br>*Last name I.O.* |