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

ONBOARD ENERGY
(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 “On-board Energy” 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 6 sections and 20 topics and is aimed at studying the fundamental principles of aerospace propulsive devices as systems, with functional requirements and engineering and environmental limitations along with requirements and limitations that constrain design choices. Both air-breathing and rocket engines are covered, at a level which enables rational integration of the propulsive system into an overall vehicle design.

The goal of mastering the discipline is to develop fundamental knowledge and skills in applying problem-solving methods necessary for professional activities, increasing the overall level of students’ literacy in the On-board Energy discipline. Students will learn to list and explain the characteristics and performance of aerospace propulsion systems, model newly-conceived rocket or air breathing propulsion systems and estimate their performance and behavior, carry out preliminary designs of rocket or air breathing propulsion systems to meet specified requirements.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline “On-Board Energy” 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)
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;; OPK-2.2 Implements and improves new methods for solving applied problems in the field of professional activity;; 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;; OPK-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.;
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;; 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;; 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;; PC-5.2 Able to develop and modernize methods for studying ballistic and dynamic characteristics when modeling spacecraft flight trajectories;;

Cipher	Competence	Indicators of Competency Achievement (within this discipline)
		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 "On-Board Energy" 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 achieving the planned results of mastering the discipline “On-Board Energy”.

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*
OPK-2	Able to improve and implement new mathematical methods for solving applied problems	Programming; Aerospace Systems; Structures & Materials Modeling;	Pre-Graduation Internship in Industry; Technological Training; Dynamics and Control of Space Systems;
OPK-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;
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; Aerospace Systems; Structures & Materials Modeling; Project "Drone Systems Engineering. Part 1"; *Applied Mechanics and Engineering***; *Systems Engineering***;	Pre-Graduation Internship in Industry; Technological Training; 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; English Language; Aerospace Systems; Structures & Materials Modeling; *Applied Mechanics and Engineering***; *Systems Engineering***; Russian as a Foreign Language;	Pre-Graduation Internship in Industry; Technological Training; Dynamics and Control of Space Systems;

Cipher	Name of competency	Previous disciplines/modules, practices*	Subsequent disciplines/modules, practices*
		Advanced Methods of Remote Sensing and Geoinformation 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 “On-board Energy” 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	Modeling of thermal rocket engines	1.1	Nozzle flow	LC, NW
		1.2	Control of mass flow	LC, NW
		1.3	Modeling of rocket nozzles	LC, NW
		1.4	Effects of nozzle area ratio	LC, NW
Section 2	Types of nozzles	2.1	Connection of flow to nozzle shape	LC, NW
Section 3	Solid propellant gas generators	3.1	Stability	LC, NW
		3.2	Grain designs	LC, NW
Section 4	Models for rocket engines	4.1	Flow of reacting gases	LC, NW
		4.2	Nozzle flow of reacting gases	LC, NW
Section 5	Aircraft propulsion	5.1	Configuration and components	LC, NW
		5.2	Aircraft engine modeling	LC, NW
		5.3	Turbojet engine	LC, NW
		5.4	Turbofan engines	LC, NW
		5.5	Inlets or diffusers	LC, NW
		5.6	Exhaust nozzles	LC, NW
		5.7	Compressors and fans	LC, NW
		5.8	Turbines, stage characteristics, degree of reaction	LC, NW
		5.9	Engine structures, centrifugal stresses, engine arrangements	LC, NW
Section 6	Aircraft engine noise: principles, regulations	6.1	Jet noise	LC, NW
		6.2	Turbomachinery noise	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.	

Audience type	Auditorium equipment	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
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. Kerrebrock, J. L. Aircraft Engines and Gas Turbines. 2nd ed. MIT Press, 1992. ISBN: 9780262111621.
2. Sutton, G. P., and O. Biblarz. Rocket Propulsion Elements. 7th ed. Wiley Interscience, 2000. ISBN: 9780471326427

Additional literature:

1. Gas Turbine Theory: By Henry Cohen, GFC Rogers, HIH Saravanamuttoo, Publisher: Addison Wesley Longman
2. Spacecraft Systems Engineering, 3rd ed. : By Peter Fortescue, John Stark and Graham Swinerd, Publisher: John Wiley & Sons

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 "On-board energy".

* - 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“On-board energy” 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.

DEVELOPERS:

		Saltykova Olga Alexandrovna
Position, PBU	*Signature*	*Last name I.O.*
		Saltykova Olga Alexandrovna
Position, PBU	*Signature*	*Last name I.O*

HEAD OF BUP:

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

HEAD OF OP VO:

		Razumny Yuri Nikolaevich
Position, PBU	*Signature*	*Last name I.O.*