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

VIRTUAL REALITY AND COMPUTER VISION
(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 “Virtual Reality and Computer Vision” 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 1st semester of the 1st year. The discipline is implemented by the Department of Mechanics and Control Processes. The discipline consists of 9 sections and 24 topics and is aimed at studying the fundamental principles of constructing virtual reality (VR) systems, remote control, devices for virtual systems, generation of three-dimensional models and images, combinations of real and artificial images, examples of applications of virtual reality systems , psychophysiological aspects of the human-machine interface in virtual systems, analysis of the basic methods for solving typical problems and familiarization with the scope of their application in professional activities.

The purpose 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 on virtual reality and computer vision.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline “Virtual reality and computer vision” 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-7	Able to search for the necessary sources of information and data, perceive, analyze, remember and transmit information using digital means, as well as using algorithms when working with data received from various sources in order to effectively use the information received to solve problems; evaluate information, its reliability, build logical conclusions based on incoming information and data	UK-7.1 Searches for the necessary sources of information and data, perceives, analyzes, remembers and transmits information using digital means, as well as using algorithms when working with data received from various sources in order to effectively use the received information to solve problems;; UK-7.2 Evaluates information, its reliability, builds logical conclusions based on incoming information and data.;
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;; 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;; 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;; PC-2.2 Can develop and implement algorithms for mathematical models based on languages and application packages for modeling;; PC-2.3 Has practical experience in developing options for implementing information systems using innovative tools.;

3. PLACE OF DISCIPLINE IN THE STRUCTURE OF HE EP

Discipline "Virtual reality and computer vision" refers to the part formed by the participants in educational relations 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 “Virtual Reality and Computer Vision”.

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-7	Able to search for the necessary sources of information and data, perceive, analyze, remember and transmit information using digital means, as well as using algorithms when working with data received from various sources in order to effectively use the information received to solve problems; evaluate information, its reliability, build logical conclusions based on incoming information and data		Advanced Methods of Remote Sensing and Geoinformation Systems; Pre-Graduation Internship in Industry; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) / Research work; 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, 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;
PC-2	Able to apply modern theoretical and experimental methods for developing mathematical models of studied objects and		Advanced Methods of Remote Sensing and Geoinformation Systems; System Design;

Cipher	Name of competency	Previous disciplines/modules, practices*	Subsequent disciplines/modules, practices*
	processes related to professional activities in the field of training and participate in their implementation in the form of software products		Project "Drone Systems Engineering. Part 1"; 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;

* - 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 discipline “Virtual Reality and Computer Vision” is “4” 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)**
			1
Contact work, ac.ch.	*20*		*20*
Lectures (LK)	10		10
Laboratory work (LR)	10		10
Practical/seminar sessions (SZ)	0		0
Independent work of students, ac.ch.	*88*		*88*
Control (exam/test with assessment), academic degree.	*36*		*36*
Total labor intensity of the discipline	**ac.ch.**	***144***	*144*
	credit units	***4***	*4*

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	Principles of constructing virtual reality systems (virtual reality, VR)	1.1	Overview of VDR systems	LK, LR
		1.2	History of the development of VDR systems	LK, LR
		1.3	Interaction between human user and reality model	LK, LR
		1.4	Simulation of operations possible with real objects	LK, LR
		1.5	Immersive perception of a reality model	LK, LR
Section 2	Principles of building augmented reality (AR) systems	2.1	3D object models used to complement real scenes	LK, LR
		2.2	Establishing a correspondence between the real user space and the data of three-dimensional models	LK, LR
		2.3	Tracking the user's position to determine his observation point in real space.	LK, LR
		2.4	Display real-time images of real scenes combined with computer graphics generated from the model.	LK, LR
Section 3	Remote control	3.1	Sensors, effectors, communication channels for virtual reality systems.	LK, LR
Section 4	Devices for virtual and augmented reality systems	4.1	Head display.	LK, LR
		4.2	Stereoscopic image output device.	LK, LR
		4.3	Audio input/output devices.	LK, LR
		4.4	Sensors for the spatial location of human body parts or tools.	LK, LR
		4.5	Input/output devices for tactile information.	LK, LR
		4.6	Motion information input/output devices.	LK, LR
Section 5	Generation of 3D models and images	5.1	Types of three-dimensional models. Rendering – creating images based on object models.	LK, LR
		5.2	Defining model surfaces. Calculation of pixel values of the generated image.	LK, LR
Section 6	Combination of real and artificial images	6.1	Texture mapping.	LK, LR
		6.2	Image-based rendering.	LK, LR

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
Section 7	Examples of applications of virtual reality systems	7.1	Inspection of architectural structures. Flight simulation. Interactive segmentation of anatomical structures.	LK, LR
Section 8	Examples of applications of augmented reality systems	8.1	Augmented reality systems used in surgery. Inspection of printed circuit boards. Projecting a car dashboard onto the windshield.	LK, LR
Section 9	Psychophysiological aspects of human-machine interface in virtual and augmented reality systems	9.1	Providing an immersive experience of the virtual environment. The need for individual configuration of devices and parameters of virtual and augmented reality systems.	LK, LR
		9.2	Side effects of virtual and augmented reality systems on humans.	LK, LR

* - 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.	
Computer class	A computer class for conducting classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with personal computers ([Parameter] pcs.), a whiteboard (screen) 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. Smolin A.A., Zhdanov D.D., Potemin I.S., Mezhenin A.V., Bogatyrev V.A. Virtual, augmented and mixed reality systems Tutorial. – St. Petersburg: ITMO University. 2018. – 59 p.

2. Azuma, Ronald T. A Survey of Augmented Reality. Presence: Teleoperators and Virtual Environments 6, 4 (August 1997), pp. 355 - 385.

Additional literature:

1. Suvorov K. A. Virtual reality systems and their application // T-Comm-Telecommunications and Transport. – 2013. – No. 9.

2. E. S. Sitnikova, T. A. Kuteneva. Virtual and augmented reality: correlation of concepts, Sociology. – 2018, p. 298-302.

3. Viger I. Virtual reality in industry. – 2016. – No. 5 (65). –CONTROL ENGINEERING RUSSIA, p. 68-71.

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 "Virtual reality and computer vision."

* - 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"Virtual reality and computer vision" 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.

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