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

Academy of Engineering

(name of the main educational unit (MEU) – developer of the educational program of higher education)

INTERNSHIP PROGRAM

Research work

(name of practice)

Educational practice

(type of practice: educational, industrial)

Recommended by the ICSC for the field of study/specialty:

27.04.04 "Control in Technical Systems"

(code and name of the training area/specialty)

Practical training of students is carried out as part of the implementation of the main professional educational program of higher education (EP HE):

**AIML and Space Sciences / Artificial Intelligence, Machine Learning and Space
Sciences**

(name (profile/specialization) of the educational institution of higher education)

1. PURPOSE OF THE INTERNSHIP

The purpose of the research work is to master the skills of independent research work on collecting, processing scientific and technical materials based on the results of research on the topic of the master's thesis and submitting them for publication in the form of scientific and technical articles, reviews, abstracts, reports, papers and lectures. These materials should be used to form the topic of the student's master's thesis.

The main objectives of the research work are:

- organization and planning educational activities;
- collection, processing, analysis and systematization of scientific and technical information of world level, including in foreign languages;
- selection of methods and means for solving problems on the research topic;
- gaining experience in using standard professional software products aimed at solving design, technological and scientific problems;
- development of plans and programs for innovative activities in the division;
- gaining experience in active interaction with colleagues in the scientific field of activity;
- preparation of scientific and technical reports, reviews, publications, scientific papers, applications for inventions, and the text of a master's thesis based on the results of completed research and other materials.

2. REQUIREMENTS FOR THE RESULTS OF TRAINING BASED ON THE RESULTS OF THE INTERNSHIP

Conducting research work is aimed at the formation of the following competencies (parts of competencies) in students:

Table 2.1. List of competencies formed in students during internship (learning outcomes based on internship results)

Cipher	Competence	Indicators of Competence Achievement (within the framework of this discipline)
UC-1	Ability to carry out critical analysis of problem situations based on a systems approach, develop an action strategy	UC-1.1. Analyzes the task, identifying its basic components;
		UC-1.2. Defines and ranks the information required to solve the assigned task;
		UC-1.3. Conducts a search for information to solve the assigned task using various types of requests;
		UC-1.4 Suggests options for solving the problem, analyzes the possible consequences of their use;
		UC-1.5 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	Able to manage a project at all stages of its life cycle	UC-2.1 Formulates a problem, the solution of which is directly related to achieving the project goal;
		UC-2.2 Defines the connections between the tasks set and the expected results of their solution;
		UC-2.3 Within the framework of the set tasks, determines the available resources and limitations, current legal norms;
		UC-2.4 Analyzes the project implementation schedule as a whole and selects the optimal way to solve the tasks set,

Cipher	Competence	Indicators of Competence Achievement (within the framework of this discipline)
		based on current legal regulations and available resources and limitations;
		UC-2.5 Monitors the progress of the project, adjusts the schedule in accordance with the monitoring results.
UC-7	The ability 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 obtained 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	UC-7.1. Knows the basic digital technologies, methods of searching, processing, analyzing, storing and presenting information used in the modern conditions of the digital economy;
		UC-7.2. Able to apply modern digital technologies to solve problems of professional activity in the conditions of the digital economy;
		UC-7.3. Has a command of modern digital technologies, methods of searching, processing, analyzing, storing and presenting information (in the field of management in technical systems) in the context of the digital economy and modern corporate information culture.
GPC-5	Ability to conduct patent research, determine forms and methods of legal protection and defense of rights to the results of intellectual activity, manage rights to them to solve problems in the development of science, technology and engineering	GPC-5.1. Knows the methods and approaches to conducting patent research, forms and methods of legal protection and defense of rights to the results of intellectual activity;
		GPC-5.2. Able to manage rights to the results of intellectual activity to solve problems in the field of development of science, engineering and technology;
		GPC-5.3. Has knowledge of methods and approaches to conducting patent research, knows methods of legal protection and defense of rights to the results of intellectual activity.
GPC-6	Ability to collect and analyze scientific and technical information, summarize domestic and foreign experience in the field of automation and control equipment	GPC-6.1. Knows the basic methods of collecting and analyzing scientific and technical information;
		GPC-6.2. Able to analyze and generalize domestic and foreign experience in the field of automation and control equipment;
		GPC-6.3. Has knowledge of methods for collecting and analyzing scientific and technical information, and can also generalize domestic and foreign experience in the professional field.
GPC-7	Capable of making informed choices, developing and implementing in practice circuit, system engineering and hardware-software solutions for automation and control systems	GPC-7.1 Able to develop and implement in practice circuit and system engineering solutions for automation and control systems;
		GPC-7.2 Can develop hardware and software solutions for automation and control systems;
		GPC-7.3 Possesses approaches for making a well-founded choice and implementing in practice circuit, system engineering and hardware-software solutions for automation and control systems.
GPC-10	Capable of managing the development of methodological and regulatory documents, technical	GPC-10.1 Familiar with the main approaches to the development of methodological and regulatory documents, technical documentation in the field of automation of technological processes and production;

Cipher	Competence	Indicators of Competence Achievement (within the framework of this discipline)
	documentation in the field of automation of technological processes and production, including on the life cycle of products and their quality	GPC-10.2 Has knowledge of approaches to managing the development of technical documentation and regulatory documents in the field of automation of technological processes and production, including the life cycle of products and their quality.
PC-1	Ability to formulate goals and objectives of scientific research in the field of application of geographic information systems in territorial development, to select methods and means for solving professional problems	PC-1.1. Knows the methods and means of solving scientific research problems in the field of application of <u>geographic information systems in territorial development</u> ;
		PC-1.2. Able to formulate the goal and objectives of scientific research in the <u>professional field</u> ;
		PC-1.3. Has mastered the techniques for formulating the goals and objectives of scientific research, and knows how to select methods and means for solving problems of professional activity.
PC-2	Ability 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	PC-2.1. Knows modern theoretical and experimental methods used to develop mathematical models of the <u>objects under study and processes of professional activity</u> ;
		PC-2.2. Able to determine the effectiveness of the methods used to develop mathematical models of the objects and <u>processes under study</u> ;
		PC-2.3. Has mastered modern theoretical and experimental methods for developing mathematical models of objects in the field of application of geographic information systems in territorial development.
PC-3	Ability to carry out design and technological work and research using geographic information systems and technologies in territorial development	PC-3.1. Knows the fundamental principles of remote sensing, basic mathematical methods and information technologies in the field of application of Earth remote sensing systems. Knows the theory and methodology of creating thematic information products and providing services based on the use of remote sensing data and geographic information systems in territorial development; knows the basic approaches to carrying out design and technological work;
		PC-3.2. Able to formulate recommendations for improving devices and systems, prepare scientific research results for publication and generate documents for filing an <u>application for an invention</u> ;
		PC-3.3. Has knowledge of methods for analyzing results obtained using geographic information systems and technologies in territorial development; is able to carry out design and technological work for territorial development using geographic information systems and remote sensing systems.
PC-4	Capable of participating in scientific research and development of design solutions in the field of ballistics, dynamics and flight control of spacecraft	PC-4.1 Familiar with the basic methods and approaches used to solve problems in the field of artificial intelligence and robotic systems;
		PC-4.2 Has knowledge of methods for solving professional problems in the field of artificial intelligence and robotic systems;
		PC-4.3 Able to apply mathematical methods and modern information technologies when conducting scientific research.

3. PLACE OF PRACTICE IN THE STRUCTURE OF THE EDUCATIONAL PROGRAM OF HIGHER EDUCATION

Research work is an optional component of the compulsory part of Block 2 Practice of the curriculum.

As part of the EP HE, students also master disciplines and/or other practices that contribute to the achievement of planned learning outcomes following completion of research work.

Table 3.1. List of components of the educational program of higher education that contribute to the achievement of planned learning outcomes following the completion of the internship

Cipher	Name of competence	Previous courses/modules, practices*	Subsequent disciplines/modules, practices*
UC-1	Ability to carry out critical analysis of problem situations based on a systems approach, develop an action strategy	History and Methodology of Science / History and methodology of science Artificial Neural Networks (Deep Learning) Artificial Neural Networks (Deep Learning)	Undergraduate Training / Pre-graduation Internship State final certification
UC-2	Able to manage a project at all stages of its life cycle	History and Methodology of Science / History and methodology of science	Undergraduate Training / Pre-graduation Internship State final certification
UC-7	The ability 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 obtained 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	History and Methodology of Science / History and methodology of science Information Technology in Mathematical Modelling / Information Technology in Mathematical Modelling Artificial Neural Networks (Deep Learning) Artificial Neural Networks (Deep Learning)	Undergraduate Training / Pre-graduation Internship State final certification
GPC-5	Ability to conduct patent research, determine forms and methods of legal protection and defense of rights to the	Machine Learning and Big Data Mining / Machine Learning	Undergraduate Training / Pre-graduation Internship State final certification

Cipher	Name of competence	Previous courses/modules, practices*	Subsequent disciplines/modules, practices*
	results of intellectual activity, manage rights to them to solve problems in the development of science, technology and engineering	and Big Data Analysis Dynamics and Control of Space Systems / Dynamics and Control of Space Systems	
GPC-6	Ability to collect and analyze scientific and technical information, summarize domestic and foreign experience in the field of automation and control equipment	Advanced Methods of Earth Remote Sensing / Modern Methods of Earth Remote Sensing	Undergraduate Training / Pre-graduation Internship State final certification
GPC-7	Capable of making informed choices, developing and implementing in practice circuit, system engineering and hardware-software solutions for automation and control systems	Advanced Methods of Space Flight Mechanics / Modern Methods of Space Flight Mechanics Dynamics and Control of Space Systems / Dynamics and Control of Space Systems	Undergraduate Training / Pre-graduation Internship State final certification
GPC-10	Capable of managing the development of methodological and regulatory documents, technical documentation in the field of automation of technological processes and production, including on the life cycle of products and their quality	Advanced Methods of Space Flight Mechanics / Modern Methods of Space Flight Mechanics	Undergraduate Training / Pre-graduation Internship State final certification
PC-1	Ability to formulate goals and objectives of scientific research in the field of application of geographic information systems in territorial development, to select methods and means for solving professional problems	Advanced Methods of Space Flight Mechanics / Modern Methods of Space Flight Mechanics Artificial Neural Networks (Deep Learning) Artificial Neural Networks (Deep Learning) Artificial Neural Networks (Reinforcement Learning)	Undergraduate Training / Pre-graduation Internship State final certification
PC-2	Ability 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	History and Methodology of Science / History and methodology of science Information Technology in Mathematical	Undergraduate Training / Pre-graduation Internship State final certification

Cipher	Name of competence	Previous courses/modules, practices*	Subsequent disciplines/modules, practices*
		Modelling / Information Technology in Mathematical Modelling Virtual Reality and Computer Vision / Virtual Reality and Computer Vision Advanced Methods of Space Flight Mechanics / Modern Methods of Space Flight Mechanics Geoinformation Systems and Applications / Geoinformation systems and their applications Dynamics and Control of Space Systems / Dynamics and Control of Space Systems Artificial Neural Networks (Deep Learning) Artificial Neural Networks (Deep Learning) Artificial Neural Networks (Reinforcement Learning)	
PC-3	Ability to carry out design and technological work and research using geographic information systems and technologies in territorial development	Virtual Reality and Computer Vision / Virtual Reality and Computer Vision Advanced Methods of Earth Remote Sensing / Modern Methods of Earth Remote Sensing	Undergraduate Training / Pre-graduation Internship State final certification
PC-4	Capable of participating in scientific research and development of design solutions in the field of ballistics, dynamics and flight control of spacecraft	History and Methodology of Science / History and methodology of science Advanced Methods of Earth Remote Sensing / Modern	Undergraduate Training / Pre-graduation Internship State final certification

Cipher	Name of competence	Previous courses/modules, practices*	Subsequent disciplines/modules, practices*
		Methods of Earth Remote Sensing Dynamics and Control of Space Systems / Dynamics and Control of Space Systems Artificial Neural Networks (Reinforcement Learning)	

* - filled in in accordance with the competency matrix and the SUP EP HE

4. SCOPE OF PRACTICE

The total workload of the research work is 18 credit units (648 academic hours).

5. CONTENT OF THE INTERNSHIP

*Table 5.1. Contents of practice**

Name of the practice section	Section content (topics, types of practical activities)	Labor intensity, ac.h.
Section 1. Organizational and preparatory	Receiving an individual assignment for practice from the supervisor	2
	Safety training at the workplace (in the laboratory and/or in production)	2
Section 2. Main	Collection of analytical data in accordance with individual assignment. Description of application processes and software.	200
	Analysis and processing of the received data	200
	Research and publication work	200
	Ongoing monitoring of the internship by the supervisor	20
	Keeping a diary of your internship	4
Preparation of the internship report		10
Preparation for defense and defense of the internship report		10
TOTAL:		648

* - the content of the practice by sections and types of practical training is FULLY reflected in the student's practice report.

6. MATERIAL AND TECHNICAL SUPPORT FOR THE INTERNSHIP

Scientific and educational laboratories of the department mechanics and management processes, premises of partner enterprises where students undergo practical training, equipped with a local network with Internet access, a projector and an interactive whiteboard.

7. METHOD OF PRACTICE

Research work can be carried out both in RUDN structural divisions or in Moscow organizations (stationary), and at bases located outside Moscow (visiting).

Conducting an internship at an external organization (outside RUDN) is carried out on the basis of a relevant agreement, which specifies the terms, place and conditions for conducting the internship at the base organization.

The internship dates correspond to the period specified in the academic calendar of the EP VO. The internship dates may be adjusted upon agreement with the Educational Policy Department and the Department for the Organization of Internships and Assistance to Graduates' Employment at RUDN.

8. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT FOR PRACTICE

Main literature:

– Classical and modern methods of automatic control theory. Textbook in 5 volumes; 2nd edition, revised and enlarged / Ed. by K.A. Pupkov, N.D. Egupov. – Moscow: Publishing House of Bauman Moscow State Technical University, 2004.

– Pupkov K.A. Modeling and testing of automatic control systems. Tutorial. – M.: RUDN, 2014. – 98s.

– Egupov N.D., Kolesnikov L.V., Pupkov K.A., Trofimov A.I. / edited by Matveev V.A. Algorithmic theory of control systems based on spectral methods. Monograph in 2 volumes. – Moscow: Publishing house of Bauman Moscow State Technical University, 2014. – 464 pages. Volume 1 and – 464 pages. Volume 2.

Further reading:

Domestic journals: Automation and Remote Control; Sensors and Systems; News of Higher Educational Institutions. Instrument Making; News of Higher Educational Institutions. Applied Nonlinear Dynamics; News of Higher Educational Institutions. Power Engineering Problems; News of the Russian Academy of Sciences. Control Theory and Systems; Information Measuring and Control Systems; Information Technology; Mathematical Modeling; Mechatronics. Automation. Control; Nonlinear World; Review of Applied and Industrial Mathematics; Devices and Systems: "Control, Monitoring, Diagnostics"; Applied Mathematics and Mechanics; Forecasting Problems; Problems of Control Theory and Practice; Control Problems; Control Systems and Information Technology; Digital Signal Processing; Open Systems; Neurocomputers: Development, Application.

Foreign journals: CAD/CAM/CAE Observer; Artificial Intelligence; IEEE Transaction on Automation Control; Control; IEEE Mechanical.

Resources of the information and telecommunications network "Internet":

1) Electronic library system (ELS) of RUDN and third-party ELS, to which the university students have access on the basis of concluded agreements:

- EBS RUDN <http://lib.rudn.ru/MegaPro/Web>
- Electronic library system "University Library Online" <http://www.biblioclub.ru>
- EBS "Yurait" <http://www.biblio-online.ru>
- Electronic Library System "Student Consultant" www.studentlibrary.ru
- EBS "Lan" <http://e.lanbook.com/>
- EBS "Troitsky Bridge"

2) Databases and search engines:

- electronic fund of legal and normative-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-methodological materials for completing the internship, filling out the diary and preparing the internship report:*

- 1) Rules for safe working conditions and fire safety during research work (initial briefing).
- 2) General structure and operating principle of technological production equipment used by students during their internship; process maps and regulations, etc. (if necessary).
- 3) Methodological instructions for students to fill out a diary and prepare a practice report.

* - all educational and methodological materials for completing the internship are posted in accordance with the current procedure on the internship page in TUIS

9. EVALUATION MATERIALS AND SCORE-RATING SYSTEM FOR ASSESSING THE LEVEL OF COMPETENCE DEVELOPMENT BASED ON THE RESULTS OF PRACTICE

Assessment materials and a scoring and rating system* for assessing the level of development of competencies (part of competencies) based on the results of passing _____ research work are presented in the Appendix to this Internship Program (module).

* - OM and BRS are formed on the basis of the requirements of the relevant local regulatory act of RUDN (regulations/procedures).

DEVELOPERS:

Associate Professor of the Department of Mechanics and Control Processes		Saltykova O.A.
_____ Position, Department	_____ Signature	_____ Surname I.O.

HEAD OF THE DEPARTMENT:

Head of the Department of Mechanics and Control Processes		Razumny Yu.N.
_____ Name of the Department	_____ Signature	_____ Surname I.O.

HEAD OF THE EP HE:

Professor of the Department of Mechanics and Control Processes		Razumny Yu.N.
_____ Position, Department	_____ Signature	_____ Surname I.O.