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**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

FROM DATA ACQUISITION TO DATA TREATMENT

(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 course "From Data Acquisition to Data Treatment" is part of the Master's program "Space mission and system design" in the field of 01.04.02 "Applied Mathematics and Informatics" and is studied in the first semester of the first year. The course is offered by the department of the Partner University. The course consists of six sections and 20 topics and is aimed at studying the fundamental principles of detectors (sensors) and transducers, grouping the sensors, the measuring device structure and characteristics, unit of measurement systems, measurement errors, measurement methods, electromechanical and electronic instruments, digital instruments, microelectronic sensors, elastic deformation measuring devices, temperature, light and radiation detectors, thermocouples, metal thermometers, semiconductor thermometers, optical gates, capacitive proximity switches, ultrasonic sensors, operating principles and properties; analysis of the main methods for solving typical problems and familiarization with their application in professional activities.

The goal of mastering the discipline is to provide students with the fundamental knowledge and skills necessary for their professional activities, as well as to improve their overall literacy in the field of From Data Acquisition to Data Treatment.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "From Data Acquisition to Data Treatment" 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-7	Able to search for relevant sources of information and data, perceive, analyze, memorize, and transmit information using digital tools, as well as algorithms when working with data obtained from various sources in order to effectively use the information obtained to solve problems; evaluate information, its reliability, and draw logical conclusions based on incoming information and data	UC-7.1 Searches for the necessary sources of information and data, perceives, analyzes, remembers and transmits information using digital means, as well as with the help of algorithms when working with data obtained from various sources in order to effectively use the information received to solve problems; UC-7.2 Conducts an assessment of 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, 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.;

Cipher	Competence	Indicators of Competency Achievement (within this discipline)
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.

3. PLACE OF THE DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL INSTITUTION

Course "Data Collection and Processing" refers to the part formed by the participants of educational relations 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 "Data Collection and Processing".

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-7	Able to search for relevant sources of information and data, perceive, analyze, memorize, and transmit information using digital tools, as well as algorithms when working with data obtained from various sources in order to effectively use the information obtained to solve problems; evaluate information, its reliability, and draw logical conclusions based on incoming information and data		Advanced Methods of Remote Sensing and Geoinformation Systems; Web Application Development and Security; Technological Training; Pre-Graduation Internship in Industry; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) / Research work;
UC-1	Capable of carrying out a critical analysis of problematic situations based on a systems approach and developing an action strategy		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; Pre-Graduation Internship in Industry; Advanced Methods of Remote Sensing and Geoinformation Systems;

Cipher	Name of competence	Previous courses/modules, practical training*	Subsequent disciplines/modules, practices*
			Structures & Materials Modeling; System Design; Dynamics and Control of Space Systems; Project "Drone Systems Engineering. Part 1";
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		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 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		Advanced Methods of Remote Sensing and Geoinformation Systems; System Design; 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;

* - 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 course “Data Collection and Processing” is 4 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)
			1
<i>Contact work, academic hours</i>	20		20
Lectures (LC)	10		10
Laboratory work (LW)	10		10
Practical/seminar classes (SC)	0		0
<i>Independent work of students, academic hours</i>	88		88
<i>Control (exam/test with assessment), academic hours</i>	36		36
Total complexity of the discipline	academic hours	144	144
	credit	4	4

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	Basic concepts of measurement	1.1	Sensors and transducers	Definition of sensors as devices that detect physical phenomena and convert them into measurable signals. Definition of transducers as devices that convert one form of energy to another. Classification of sensors: active and passive, analog and digital. Examples of common sensors in engineering applications.	LC, LW
		1.2	The structure and characteristics of the measuring apparatus	General structure of a measuring system: sensing element, signal conditioning, data processing, and display. Key characteristics of measuring apparatus: sensitivity, accuracy, precision, resolution, range, linearity, hysteresis, repeatability, and stability. Static and dynamic characteristics.	LC, LW
		1.3	Measurement Systems. Measurement errors	Components of a complete measurement system. Sources of measurement errors: systematic errors, random errors, and gross errors. Accuracy versus precision. Error propagation in measurement chains. Methods for error reduction and compensation.	LC, LW
		1.4	Measurement methods	Direct and indirect measurement methods. Absolute and relative measurements. Comparison methods, deflection methods, and null methods. Contact and non-contact measurement techniques. Selection of appropriate measurement method based on application requirements.	LC, LW
Section 2	Theoretical basis of Light electric effect sensors	2.1	The photodiode and photovoltaic structure, modes of operation and application	Principle of the photoelectric effect. Photodiode structure: PN junction design. Modes of operation: photovoltaic mode, photoconductive mode. Applications: light detection, optical communications, medical equipment. Spectral response and sensitivity characteristics.	LC, LW
		2.2	Multi-color LEDs	Structure of multi-color light emitting diodes. Principles of color generation: RGB and other color mixing techniques. Characteristics: emission spectrum, brightness control, switching speed. Applications: displays, indicator systems, color sensing, optical measurement systems.	LC, LW
		2.3	The structure and characteristics of optical interfaces	Definition of optical interfaces for signal transmission between components. Types of optical interfaces: fiber optic interfaces, free-space optical interfaces. Characteristics: bandwidth, attenuation, noise immunity, transmission distance. Applications in	LC, LW

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				measurement systems and data acquisition.	
		2.4	The scanner structure and characteristics of CCD sensors	Charge-Coupled Device sensor structure: array of light-sensitive elements. Operating principle: charge accumulation and transfer. Characteristics: resolution, quantum efficiency, dynamic range, readout speed. Applications in scanners, cameras, and imaging measurement systems.	LC, LW
Section 3	Types of photo resist and application	3.1	The structure and features of a phototransistor	Phototransistor structure: bipolar transistor with photosensitive base region. Operating principle: light-induced base current leading to amplified collector current. Features: current gain, sensitivity, response time. Applications: light detection, optical switches, position sensing.	LC, LW
		3.2	The structure and use of a light pencil	Definition and structure of a light pencil as a handheld optical input device. Operating principle: light emission and detection for pointing or measurement. Uses: data acquisition from surfaces, barcode reading, interactive displays.	LC, LW
		3.3	The structure, characterization and application of a liquid crystal display	Liquid Crystal Display structure: liquid crystal layer, polarizers, electrodes, backlight. Operating principle: electric field alignment of liquid crystals controlling light transmission. Characterization parameters: contrast ratio, viewing angle, response time, power consumption. Applications: measurement system displays, instrumentation panels.	LC, LW
		3.4	Measurement of LED characteristics	Methods for measuring LED parameters: light intensity, forward voltage, emission spectrum, viewing angle. Equipment used: photometers, spectrometers, integrating spheres. Interpretation of measurement results for quality control and system design.	LC, LW
Section 4	Measuring elastic deformation instruments	4.1	Piezoelectric and piezoresistive sensors	Piezoelectric effect: generation of electric charge under mechanical stress. Piezoelectric sensor structure and materials: quartz, ceramics. Piezoresistive effect: change in electrical resistance under strain. Comparison of piezoelectric and piezoresistive sensors. Applications: dynamic pressure measurement, acceleration sensing, force sensing.	LC, LW
		4.2	Elastic deformation measuring instruments	Principles of elastic deformation measurement. Strain gauges: structure, types, and bonding techniques. Load cells and force transducers based on elastic elements. Measurement of displacement using elastic elements. Calibration and temperature compensation.	LC, LW

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
		4.3	Microelectronic capacitive pressure sensors	Principles of elastic deformation measurement. Strain gauges: structure, types, and bonding techniques. Load cells and force transducers based on elastic elements. Measurement of displacement using elastic elements. Calibration and temperature compensation.	LC, LW
		4.4	PN-gradient sensors and the MOSFET structure	PN-gradient sensors: principle of position sensing using lateral photoeffect. Structure of Metal-Oxide-Semiconductor Field-Effect Transistor for sensing applications. Operating principles of MOSFET-based sensors. Applications: position sensing, chemical sensing, biological sensing.	LC, LW
		4.5	Measurement of elastic deformation	Experimental methods for measuring elastic deformation in materials and structures. Use of strain gauges, extensometers, and optical methods. Data acquisition and processing. Interpretation of stress-strain relationships.	LC, LW
Section 5	Thermoelectric sensors	5.1	The operating principles, construction and characteristics of an infrared motion sensor	Operating principle of passive infrared sensors: detection of infrared radiation emitted by warm objects. Construction: pyroelectric sensor, Fresnel lens, signal conditioning electronics. Characteristics: detection range, field of view, response time, sensitivity. Applications: motion detection, security systems, occupancy sensing.	LC, LW
		5.2	Thermoelectric transducer coupling, the PVDF film. Thermocouples, semiconductor structure, function and features of metal thermometers and other thermometers.	Thermoelectric transducer coupling principles. PVDF film as a pyroelectric and piezoelectric material. Thermocouples: Seebeck effect, types, construction, temperature range, accuracy. Semiconductor temperature sensors: diode-based and IC-based sensors. Metal thermometers: resistance temperature detectors, thermistors. Comparison of thermometer types. Selection criteria for temperature measurement applications.	LC, LW
Section 6	An optical gate	6.1	Its structure, working principle and characteristics and application areas	Structure of an optical gate: light source typically an LED or laser, photodetector, and signal processing electronics. Working principle: interruption or reflection of light beam between emitter and detector. Characteristics: response time, detection distance, ambient light immunity, output type. Operating modes: through-beam, retro-reflective, diffuse reflective. Application areas: speed measurement, position sensing, object counting, safety systems, automation and industrial control.	LC, LW

* - 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.	
Computer class	A computer room for conducting classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with personal computers (in the amount of ____ units), a board (screen) 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. Aciatore, David G.: Introduction to mechatronics and measurement systems, Boston, 2007
2. Ed. Robert H. Bishop: The Mechatronics Handbook, Section III: Sensors and actuators

Further reading:

1. David G. Alciatore, Michael B. Histan: Introduction to mechatronics and measurement systems 1st. McGraw-Hill, 2013
2. UA Bakshi – VU Bakshi: Electronic Measurement and Instrumentation 1st. Technical Publications Pune, 2009

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 "Data collection and processing".

* - 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

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Surname I.O.

HEAD OF THE DEPARTMENT:

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