**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

## ADVANCED METHODS OF EARTH REMOTE SENSING
(name of discipline/module)

**Recommended for the field of study/specialty:**

## 27.04.04 CONTROL IN TECHNICAL SYSTEMS
(code and name of the training area/specialty)

**The discipline is mastered within the framework 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)

**2025**

## 1. THE GOAL OF MASTERING THE DISCIPLINE

The course "Advanced Methods of Earth Remote Sensing" is part of the Master's program "Artificial Intelligence, Machine Learning and Space Sciences" in the direction 27.04.04 "Control in Technical Systems" and is studied in the 2nd semester of the 1st year. The course is implemented by the Department of Mechanics and Control Processes. The course consists of 4 sections and 7 topics and is aimed at studying and acquiring practical skills in solving problems related to obtaining, processing and applying remote sensing data of the Earth from space.

The purpose of mastering the discipline is to obtain knowledge, skills, abilities and experience in the field of remote sensing of the earth, characterizing the stages of formation of competencies and ensuring the achievement of the planned results of mastering the educational program

## 2. REQUIREMENTS TO THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline " Advanced Methods of Earth Remote Sensing" is 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 Competence Achievement** (within the framework of this discipline) |
|---|---|---|
| GPC-1 | Able to analyze and identify the natural scientific essence of control problems in technical systems based on provisions, laws and methods in the field of natural sciences and mathematics | GPC-1.1 Knows the basic laws, provisions and methods in the field of natural sciences and mathematics;<br>GPC-1.2 Able to identify the natural scientific essence of control problems in technical systems, guided by the laws and methods of natural sciences and mathematics;<br>GPC-1.3 Has command of tools for analyzing control problems in technical systems. |
| GPC-4 | Capable of assessing the effectiveness of the results of developing control systems using mathematical methods | GPC-4.1 Knows the basic mathematical methods used to evaluate the effectiveness of the results of control systems;<br>GPC-4.2 Able to apply mathematical methods to evaluate the effectiveness of the results of control systems;<br>GPC-4.3 Proficient in methods for assessing the effectiveness of management systems. |
| GPC-6 | Capable of collecting and analyzing scientific and technical information, generalizing 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;<br>GPC-6.2 Able to analyze and generalize domestic and foreign experience in the field of automation and control equipment;<br>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.; |
| PC-3 | Capable of carrying out work and research on the processing and analysis of scientific and technical information obtained using geographic information systems and technologies | PC-3.1 Able to analyze the results of theoretical and experimental research;<br>PC-3.2 Able to formulate recommendations for improving devices and systems, prepare scientific research results for publication and generate documents for filing an application for an invention;<br>PC-3.3 Participates in the analysis of research results, has the skills to formulate recommendations for improving devices and systems, as well as writing articles and submitting documents for registration of inventions.; |
| 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;<br>PC-4.2 Has knowledge of methods for solving professional problems in the field of artificial intelligence and robotic systems;<br>PC-4.3 Able to apply mathematical methods and modern information technologies when conducting scientific research.; |

## 3. PLACE OF THE DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL EDUCATIONAL EDUCATION

Discipline " Advanced Methods of Earth Remote Sensing" refers to the mandatory part 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 " Advanced Methods of Earth Remote Sensing".

*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, practices* | Subsequent disciplines/modules, practices* |
|---|---|---|---|
| GPC-6 | Capable of collecting and analyzing scientific and technical information, generalizing domestic and foreign experience in the field of automation and control equipment | Machine Learning and Big Data Mining; | Undergraduate Training; Research work / Scientific research work; |
| GPC-1 | Able to analyze and identify the natural scientific essence of control problems in technical systems based on provisions, laws and methods in the field of natural sciences and mathematics | Virtual Reality and Computer Vision; Numerical Methods for Solving Mathematical Modeling Problems; Information Technology in Mathematical Modeling; Programming Technology; | Geoinformation Systems and Applications; Undergraduate Training; |
| GPC-4 | Capable of assessing the effectiveness of the results of developing control systems using mathematical methods | History and Methodology of Science; | Dynamics and Control of Space Systems; Undergraduate Training; |
| PC-3 | Capable of carrying out work and research on the processing and analysis of scientific and technical information obtained using geographic information systems and technologies | Virtual Reality and Computer Vision; | Research work / Scientific research work; Undergraduate Training; |
| 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; | Dynamics and Control of Space Systems; *Artificial Neural Networks (Reinforcement Learning)***; Research work / Scientific research work; Undergraduate Training; |

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

** - elective disciplines/practices

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

The total workload of the course “Advanced Methods of Earth Remote Sensing” is “6” 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,**ac.h. | | **Semester(s)** |
|---|---|---|---|
| | | | **2** |
| *Contact work, academic hours* | *72* | | *72* |
| Lectures (LC) | 36 | | 36 |
| Laboratory work (LW) | 36 | | 36 |
| Practical/seminar classes (SC) | 0 | | 0 |
| *Independent work of students, academic hours* | *117* | | *117* |
| *Control (exam/test with assessment), academic hours* | *27* | | *27* |
| **General complexity of the discipline** | **ac.h.** | ***216*** | *216* |
| | **credit.ed.** | ***6*** | *6* |

## 5. CONTENT OF THE DISCIPLINE

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

| Section number | Name of the discipline section | Section Contents (Topics) | | Type of academic work* |
|---|---|---|---|---|
| Section 1 | Introduction. | 1.1 | Definition and overview of the history of remote sensing and the evolution of remote sensing and remote sensing system. | OK |
| | | 1.2 | Electromagnetic radiation (EMR), terms and definitions, radiation laws, EM spectrum, EMR sources. | OK |
| Section 2 | Remote Sensing Systems | 2.1 | Active and passive systems, mapping and other systems, the concept of resolution in remote sensing - spatial, spectral, radiometric and temporal. | OK |
| | | 2.2 | Orbits and platforms for Earth observation. | OK |
| Section 3 | Receiving and processing images | 3.1 | Reception, processing and creation of information products. | LC, LW |
| | | 3.2 | Mastering the freely distributed MultiSpec program for analyzing multi-spectral Landsat data (using various objects and industries as examples). | LC, LW |
| Section 4 | Applications | 4.1 | Applied use of remote sensing in Earth, Ocean, Atmospheric, Hazardous Materials and Climate Change Sciences. | LC, LW |

* - filled in only for FULL-TIME education: LC – lectures; LW – laboratory work; PW – practical/seminar classes.

## 6. LOGISTIC AND TECHNICAL SUPPORT OF DISCIPLINE

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

| Audience type | Equipping the auditorium | 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; a board (screen) and technical means for multimedia presentations. | |
| 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 [Parameter] pcs.), a board (screen) and technical means for multimedia presentations. | |
| Seminar | An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with a set of specialized furniture and technical means for multimedia presentations. | |

| Audience type | Equipping the auditorium | Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary) |
|---|---|---|
| For independent work | A classroom for independent work of students (can be used for conducting seminars and consultations), equipped with a set of specialized furniture and computers with access to the Electronic Information System. | |

* - the audience for independent work of students MUST be indicated!

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

*Main literature:*

1. George Joseph: Fundamentals of Remote Sensing; Universities Press India Pvt Ltd, Hyderabad, India

2. Editors: John D. Bossler; John R. Jensen; Robert B. McMaster; Chris Rizos, 2001. Manual of Geospatial Science and Technology, November 2001, Vol 1 Part 1and II.

*Further reading:*

1. T. Takagi, T. Oguchi, J. Matsumoto, M. J. Grossman, M. H. Sarker, M. A. Matin (2007) Channel braiding and stability of the Brahmaputra River, Bangladesh, since 1967: GIS and remote sensing analyses, Geomorphology 85, 294–305

2. John D. Bossler; John R. Jensen; Robert B. McMaster; Chris Rizos, (Editors), 2001. Photogrammetric and remote sensing considerations; Chapter 16, Manual of Geospatial Science and Technology, Vol 1 Part 4 Pages 233 – 252

*Resources of the information and telecommunications network "Internet":*

1. RUDN University EBS and third-party EBSs to which university students have access on the basis of concluded agreements

- Electronic library system of RUDN - ELS RUDN https://mega.rudn.ru/MegaPro/Web
- Electronic library system "University library online"http://www.biblioclub.ru
- EBS Yuraithttp://www.biblio-online.ru
- Electronic Library System "Student Consultant" www.studentlibrary.ru
- EBS "Znanium"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 "Modern methods of remote sensing of the Earth".

* - all educational 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 | | Dryga Danil Olegovich |
|---|---|---|
| *Position, Department* | *Signature* | *Surname I.O.* |

**HEAD OF THE DEPARTMENT:**

| Head of Department | | Razumny Yuri Nikolaevich |
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