Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA NAMED AFTER PATRICE LUMUMBA
(RUDN University)

Academy of Engineering
(Name of the Department-Developer of the Higher Education Programme)

WORKING PROGRAM OF EDUCATIONAL COURSE

SYSTEM ANALYSIS, CONTROL AND INFORMATION PROCESSES, STATISTICS
(Name of the Course)

Recommended by the Methodological Council for the Education Field:

2.3.1. System Analysis, Control and Information Processes, Statistics
(the code and the name of the training direction/specialty)

The course is part of the Higher Education Programme:

System Analysis, Control and Information Processes, Statistics
(Name of the Higher Education Programme, major/area of study)

2023

1. COURSE GOALS

The aim of the course "System analysis, management and information processing, statistics" is to form a system of scientific knowledge and professional competencies in the field of modern methods of system analysis, management and information processing in postgraduate students.

2. REQUIREMENTS FOR THE OUTCOMES OF THE COURSE

As a result of mastering the course "System analysis, management and information processing, statistics" the postgraduate student should:

Know the main modern methods of implementation of complex programs, modern scientific literature and journal articles in the periodical press devoted to such problems.

To be able to identify actual modern theoretical problems of system analysis, control and information processing and to explain on this basis the existing facts and processes of development of approximate methods in modern mathematics.

To find and comprehend new facts, processes and trends characterizing the formation, evolution and transformation of systems analysis, management and information processing in historical retrospect, as well as rethink previously known facts, processes and trends.

3. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The course "System analysis, management and information processing, statistics" has a total of "3" credit units.

Table 3.1. Types of study by period of study in a higher education programme for full-time study.

Type(s) of academic activities		**TOTAL,** ac.h	**Semester(s)**
			3
Contact academic hours		*30*	*30*
Lectures (**L**)		30	30
Lab work (**LW**)			
Seminars (**S**)		30	30
Self-study, ac.h.		*48*	*48*
Evaluation and assessment, ac.h.			
Course workload	ac.h	**108**	**108**
	cred.	3	**3**

4. COURSE CONTENTS

Table 4.1. Content of the course by type of study

Name of the Course Section	Section Content (subjects)	Type of study *
Section 1: Topical issues in systems analysis.	Mathematical models of mechanical systems, multi-link robots. The laws of mechanics for constructing mathematical models. Lagrange method. Dalamber's principle. Examples of constructing mathematical models of mechanical objects. Uncertainties in mathematical models. Probabilistic methods of uncertainty description. Fuzzy forms of uncertainty description. Methods for solving parametric identification problems. Structural uncertainty. Problems of solving structural identification problem and structural-parametric identification problem. Mathematical models of flying vehicles, flying robots. Non-parametric identification of nonlinear systems. Pontryagin's maximum principle. Problems of solving optimal control task. Computing methods for solving optimal control tasks. Bellman's equation. Analytical design of optimum controllers. Lyapunov Functions Method for Synthesis of Stabilizing Systems. The method of analytical design of aggregated regulators. The problem of uncertainty in the problem of control synthesis.	**L, S**
Section 2: Topical issues of management.	Formulation of the task of numerical synthesis of control systems. Optimal robust control. H2 and H∞ - Theory of Optimal Control. Representation of a random process by methods of polynomial chaos theory. Probabilistic uncertainty in stochastic dynamic control systems. Artificial Neural Networks. The Widrow-Hoff Delta Rule and the Error Backpropagation Algorithm. Adaptive control systems based on neural networks. Neural networks for identification tasks. Neural network method for solving the tasks of control synthesis. Genetic algorithm. Algorithm of differential evolution. Ant colony algorithm. Bee swarm algorithm. Particle swarm algorithm. Principle of small variations of basis solution for solving numerical and nonnumerical optimization problems.	**L, S**

Name of the Course Section	Section Content (subjects)	Type of study *
Section 3. Topical issues of information processing	A variational genetic algorithm for training a neural network. A variational genetic algorithm for solving an optimal control problem. Genetic programming method. A method for variational genetic programming. Method of grammar evolution. Method for variational grammatical evolution. Analytical programming method. The method of variational analytical programming. Network operator method. Multilayer network operator method. Solving identification and control synthesis problems by symbolic regression methods. The solution of the task of optimum control by the method of symbolic regression. Systems with shared memory. Systems with distributed memory. Graphical accelerators Parallel technology software. OpenMP, MPI, OpenCL, CUDA libraries. Parallelization efficiency evaluation.	**L, S**

5. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Classroom for Academic Activity Type	Classroom equipment	Specialised training/laboratory equipment, software and materials for the course (if needed)
Lecture room	Room for lecture-type classes, equipped with a set of specialised furniture; a blackboard (screen) and technical means of multimedia presentations.	A postgraduate student's individual workplace should be equipped with a personal device with internet access. A mobile phone is not a device technically capable of providing access to all information resources and services for mastering the modules. Computer classrooms should be equipped with multimedia and computer equipment with access to the Internet.
Seminar room	Room for seminar-type classes, group and individual consultations, current control and intermediate attestation, equipped with a set of specialised furniture and technical means of multimedia presentations.	
Computer class	Computer room for classes, group and individual consultations, current control and interim certification, equipped with personal computers (5 pcs.), blackboard (screen) and technical means of multimedia presentations.	
Self-study room	Room for students' self-study (can be used	

Classroom for Academic Activity Type	Classroom equipment	Specialised training/laboratory equipment, software and materials for the course (if needed)
	for seminars and consultations), equipped with a set of specialised furniture and computers.	

6. RECOMMENDED SOURCES FOR COURSE STUDIES

Primary literature:

1. Diveev A.I., Sofronova E.A. Network operator method and its application in control problems. Moscow: PFUR Publishing House, 2012. - 182 c.

Additional literature:

1. Bobenko A. I., Suris Y. B. Discrete Differential Geometry. The integrable structure - M. ; Izhevsk : NIC "Regular and Chaotic Dynamics" : Izhevsk Institute for Computer Research, 2010. - 448 c.
2. Samarskii A. A., Vabishchevich P. Numerical methods of solving inverse problems of mathematical physics: tutorial. - M. : Publishing house LKI, 2014. - 480 c.
3. Naatz V. I., Naatz I. E. Mathematical models and numerical methods in the tasks of ecological monitoring of the atmosphere : Monograph - Moscow : FIZMATLIT, 2010. - 328 c.
4. A. V. Rumyantsev. A Finite Element Method in Problems of Heat Conduction: Textbook - Kaliningrad: Publishing house of KSU, 1995. - 170 c.:
5. Sveshnikov A.G. et al. Linear and non-linear Sobolev type equations - M. : Fizmatlit, 2007. - 736 c.

Information and telecommunication network resources on the Internet:

1. Digital Library System (DLS) of RUDN University and of other third-party organizations to which university students have access on the basis of contracts:
   - RUDN DLS: http://lib.rudn.ru/MegaPro/Web
   - DLS University library online (in Russian: «Университетская библиотека онлайн») http://www.biblioclub.ru
   - DLS “Yurite” (in russian: Юрайт) http://www.biblio-online.ru
   - DLS “Student Advisor” (in Russian: «Консультант студента») www.studentlibrary.ru
   - DLS “Troitsky Bridge” (in Russian: «Троицкий мост»)
2. Database and search engines
   - Electronic collection of legal, regulatory and technical documentation http://docs.cntd.ru/
   - Yandex search engine: https://www.yandex.ru/
   - Google search engine: https://www.google.ru/
   - reference database SCOPUS http://www.elsevierscience.ru/products/scopus/

Teaching materials for students' self-study while mastering the course/module:*

1. Course lectures «System Analysis, Control and Information Processes, Statistics».

* - All teaching materials for students' self-study are published according to the current procedure on the **TUIS** course page!

7. MID-TERM ASSESSMENT AND EVALUATION TOOLKIT

Assessment materials and scoring and rating system* for assessing the level of competence (part of competences) for the course "System Analysis, Control and Information Processes, Statistics" are presented in the Appendix to this Working Programme of Educational Course.

* - Assessment materials and scoring system are formed based on the requirements of the RUDN local normative act.

DEVELOPERS:

Professor		A.I. Diveev
Position, Department	*Signature*	*Name, Patronymic Name, Surname*

HEAD OF THE HIGHER EDUCATION PROGRAMME:

Professor		Yuri N. Razoumny
Position, Department	*Signature*	*Name, Patronymic Name, Surname*

HEAD OF THE DEPARTMENT:

Head of the Department of Mechanics and Control Processes		Yuri N. Razoumny
Position, Department	*Signature*	*Name, Patronymic Name, Surname*