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ФИО: Ястребов Олег Александрович  
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**Federal State Autonomous Educational Institution of Higher Education  
"Peoples' Friendship University of Russia"  
(RUDN University)**

**Academy of Engineering**

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(Name of the main educational unit (MEU)- of the developer of the EP of HE)

## **COURSE SYLLABUS**

**System Analysis, Control and Information Processes / Системный анализ,  
управление и обработка информации**

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(Name of the discipline/module)

**Recommended by the Methodological Council for the Education Field:**

**2.3.1 System Analysis, Control and Information Processes / Системный  
анализ, управление и обработка информации**

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(code and name of the direction of training / specialization)

**The development of the discipline is carried out as part of the implementation of the  
postgraduate program:**

**System Analysis, Control and Information Processes / Системный анализ,  
управление и обработка информации**

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(name (profile/specialization) EP HE)

2022 г.

## 1. THE PURPOSE OF MASTERING THE DISCIPLINE

**The purpose** of mastering the discipline "System Analysis, Control and Information Processes" is the formation of a system of scientific knowledge and professional competencies in postgraduate students in the field of modern methods of system analysis, management and information processing.

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

As a result of mastering the discipline "System Analysis, Control and Information Processes", a graduate student must:

To know the main modern methods for the implementation of software packages, modern scientific literature and journal articles in the periodical press devoted to such problems.

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

Possess the skills of finding and comprehending new, as well as rethinking previously known facts, processes and trends that characterize the formation, evolution and transformation of system analysis, management and information processing in historical retrospect.

## 3. VOLUME OF DISCIPLINE AND TYPES OF EDUCATIONAL WORK

The total labor intensity of the discipline "System Analysis, Control and Information Processes" is 3 credits.

*Table 3.1. Types of educational work by periods of mastering the postgraduate program*

Type of educational activity	Total number of hours	Semester(s)			
		1	2	3	4
<i>Contact academic hours</i>	60		60		
Including:					
<i>Lectures (L)</i>	30		30		
<i>Lab work (LW)</i>					
<i>Seminars (workshops/tutorials) (S)</i>	30		30		
<i>Self-study(ies)</i>	48		48		
<i>Evaluation and assessment (exam/pass/fail grading)</i>					
<b>Total labor intensity</b>	<b>hour</b>	<b>108</b>	<b>108</b>		
	<b>CU</b>	<b>3</b>	<b>3</b>		

## 4. CONTENT OF THE DISCIPLINE

*Table 4.1. The content of the discipline (module) by type of educational work*

<b>Name of the discipline section</b>	<b>Contents of the section (topic)</b>	<b>Type of study work</b>
Topical issues of system analysis.	Mathematical models of mechanical systems, multilink robots. The laws of mechanics for building mathematical models. Lagrange method. d'Alembert principle. Examples of constructing mathematical models of mechanical objects. Uncertainties in mathematical models. Probabilistic methods for describing uncertainties. Fuzzy forms of description of uncertainties. Methods for solving problems of parametric identification. Structural uncertainty. Problems of solving the problem of structural identification and structural-parametric identification. Mathematical models of aircraft, flying robots. Nonparametric identification of nonlinear systems. Pontryagin's maximum principle. Problems of solving the problem of optimal control. Computational methods for solving optimal control problems. Bellman equation. Analytical Design of Optimal Controllers (ACOR). The method of Lyapunov functions for the synthesis of stabilization systems. Analytical design method for aggregated controllers. The problem of uncertainty in the problem of control synthesis.	<b>L, S</b>
Current issues of management.	Formulation of the problem of numerical synthesis of control systems. Optimal robust control. $H_2$ and $H_\infty$ - theory of optimal control. Representation of a random process by methods of the theory of polynomial chaos. Probabilistic uncertainty in stochastic dynamic control systems. Artificial neural networks. Delta Widrow-Hoff rule and backpropagation algorithm. Adaptive control system based on neural networks. Neural networks for solving identification problems. Neural network method for solving problems of control synthesis. Genetic algorithm. Algorithm of differential evolution. Ant colony algorithm. Bee swarm algorithm. Particle Swarm Algorithm. The principle of small variations of the basic solution for solving problems of numerical and non-numerical optimization.	<b>L, S</b>
Current issues of information processing	Variational genetic algorithm for neural network training. Variational genetic algorithm for solving the optimal control problem. Method of genetic programming. Method of variational genetic programming. Method of grammatical evolution. The method of variational grammatical evolution. Method of analytical programming. Method of variational	<b>L, S</b>

Name of the discipline section	Contents of the section (topic)	Type of study work
	analytical programming. Network operator method. Multilayer network operator method. Solving problems of identification and synthesis of control methods of symbolic regression. Solution of the optimal control problem by the symbolic regression method. Systems with shared memory. Distributed memory systems. Graphic accelerators Software tools of parallel technologies. Libraries OpenMP, MPI, OpenCL, CUDA. Estimates of the efficiency of parallelization.	

## 5. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

*Table 5.1. Technical equipment for the discipline*

Audience type	Audience equipment	Specialized educational / laboratory equipment, software and materials for mastering the discipline (if needed)
Lecture	An auditorium for lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations.	Computer classroom equipped with 25 workstations with a personal computer, specialized software for laboratory work and practical lessons
Labor	An auditorium for laboratory work, individual consultations, current control and intermediate certification, equipped with a set of specialized furniture and equipment.	Classroom equipped with 30 workstations for lectures and group lessons
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, current control and intermediate certification,	Computer classroom equipped with 25 workstations with a personal computer, specialized software for laboratory work and practical lessons

	equipped with a set of specialized furniture and technical means for multimedia presentations.	
Computer class	Computer class for conducting classes, group and individual consultations, current control and intermediate certification, equipped with personal computers (in the amount of _____ pcs.), Board (screen) and multimedia equipment презентаций.	
Individual work	An auditorium for independent work of students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to the EIES.	

## 6. EDUCATIONAL-METHODOLOGICAL AND INFORMATION SUPPORT OF THE DISCIPLINE

### *Main literature:*

1. Diveev A.I., Sofronova E.A. *Network operator method and its application in control problems*. M.: Publishing House of RUDN University, 2012. - 182 p.

### *additional literature*

2. A. I. Bobenko and Yu. B. Suris, *Discrete Differential Geometry. Integrable structure* - M.; Izhevsk: Research Center "Regular and Chaotic Dynamics": Izhevsk Institute of Computer Research, 2010. - 448 p.

3. Samarsky A. A., Vabishchevich P. N. *Numerical methods for solving inverse problems of mathematical physics: Textbook*. - M. : Publishing house LKI, 2014. - 480 p.

4. Naats V. I., Naats I. E. *Mathematical models and numerical methods in problems of ecological monitoring of the atmosphere: Monograph* - M. : FIZMATLIT, 2010. - 328 p.

5. A. V. Rummyantsev. *Finite element method in heat conduction problems: Textbook* - Kaliningrad: Publishing house of KGU, 1995. - 170 p.:

6. Sveshnikov A. G. et al. *Linear and nonlinear equations of the Sobolev type* - M. : Fizmatlit, 2007. - 736 p.

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

1. ELS of RUDN University and third-party ELS, to the materials of which graduate students of the university have access on the basis of concluded agreements:

- RUDN Electronic Library System - RUDN EBS <http://lib.rudn.ru/MegaPro/Web>

- ELS "University Library Online" <http://www.biblioclub.ru>

- EBS - "Educational Platform Urayt" <http://www.biblio-online.ru>

- ELS "Student Consultant" [www.studentlibrary.ru](http://www.studentlibrary.ru) , integrated into ELS RUDN

University

- EBS "Lan" <http://e.lanbook.com/>

- EBS "Troitsky Most", integrated into the ELS of RUDN University

- EBS BOOKUP - professional medical literature <http://books-up.ru/>

2. Databases\*

\* information about universal and specialized information bases for selection and inclusion in the program must be taken from the website of the UNIBC (NB), link to the section <https://lib.rudn.ru/8>

- SCOPUS - scientometric, abstract database with organized access to open access publications <http://www.elsevier.com/locate/scopus/>

- WOS - scientometric, abstract database with organized access to open access publications [webofscience.com](http://www.webofscience.com)

- Google Academy (English Google Scholar) - <https://scholar.google.ru/>

- NEB, RSCI on the platform eLibrary.ru - <https://elibrary.ru/>

- RUDN University repository - <https://repository.rudn.ru/>

3. 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/>

*Educational and methodological materials for independent work of students in the development of the discipline / module.*

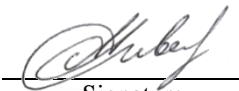
*All educational and methodological materials for independent work of students are placed in accordance with the current procedure on the page of the discipline in TUIS!*

## 7. EVALUATION MATERIALS AND SCORE-RATING SYSTEM FOR ASSESSING THE LEVEL OF FORMATION OF COMPETENCES IN THE DISCIPLINE

Evaluation materials and a point-rating system for assessing the development of the discipline 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 normative act of the Peoples' Friendship University of Russia.

### DEVELOPERS:

<b>Prof. DMCP</b> _____ Position, BUP	 _____ Signature	<b>Diveev A.I.</b> _____ Surname I.O.
<b>HEAD of DMCP</b> _____ Name of BUP	 _____ Signature	<b>Razoumny U.N.</b> _____ Surname I.O.