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**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**

### **DYNAMICS, BALLISTICS, CONTROL OF MOTION OF AIRCRAFT AND SPACECRAFT**

(Name of the Course)

Recommended by the Methodological Council for the Education Field:

#### **2.5.16. Dynamics, Ballistics, Control of Motion of Aircraft and Spacecraft**

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

The course is part of the professional program of higher education:

#### **Dynamics, Ballistics, Control of Motion of Aircraft and Spacecraft**

(Name of the professional program of higher education, major/area of study)

## 1. COURSE GOALS

The purpose of mastering the discipline "Dynamics, Ballistics, Control of Motion of Aircraft and Spacecraft" is to form a postgraduate system of scientific knowledge of promising methods of research and solution of professional problems, taking into account global trends in the development of aviation and rocket-space technology.

## 2. REQUIREMENTS FOR THE OUTCOMES OF THE COURSE

As a result of mastering the discipline "Dynamics, Ballistics, Control of Motion of Aircraft and Spacecraft" a graduate student must:

Know new methods of development and research of methods of analysis, synthesis, optimization and forecasting of quality of processes of functioning of aviation and rocket-space technology

Master new methods of selecting and transforming mathematical models of phenomena, processes and systems in the field of rocket and space technology with the aim of their research and implementation by means of computer technology

To be able to use new methods of mathematical models development, methods, computer technologies and decision-making support systems in scientific research, engineering and design activity, management of technological, economic, social systems and in humanitarian spheres of human activity

## 3. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The course "Dynamics, Ballistics, Control of Motion of Aircraft and Spacecraft" has a total of "1" credit unit.

*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
<i>Contact academic hours</i>			
Lectures (L)		30	30
Lab work (LW)			
Seminars (S)		30	30
<i>Self-study, ac.h.</i>		48	48
<i>Evaluation and assessment, ac.h.</i>			
Course workload	ac.h	108	108
	cred.	3	3

## 4. COURSE CONTENTS

*Table 4.1. Content of the course by type of study*

<b>Name of the Course Section</b>	<b>Section Content (subjects)</b>	<b>Type of study*</b>
Section 1. Dynamic properties of the aircraft as a control object	Topic 1.1. Ballistic and Dynamic Design Problem Setting	L, S
	Topic 1.2. Principle of perturbed-unperturbed motion. Advisability of transition to perturbed motion	L, S
	Topic 1.3. Linearization as a method for transforming equations to a form suitable for obtaining a general solution	L, S
	Topic 1.4. Separation of perturbed motion into longitudinal and lateral motion	L, S
	Topic 1.5 Composing linear equations of perturbed motion of aircraft Dynamic coefficients	L, S
	Topic 1.6. Free and forced perturbation	L, S
	Topic 1.7. Longitudinal perturbed motion	L, S
	Topic 1.8. Characteristic equation and its possible roots. Main conclusions on stability and structure of perturbed motion	L, S
	Topic 1.9. Two stages of evolution of free longitudinal perturbed motion	L, S
	Topic 1.10. Transfer function of aircraft. Concept of transfer coefficient of an aircraft	L, S
	Topic 1.11. Frequency characteristics of aircraft	L, S
	Topic 1.12. Basic requirements for aircraft dynamic properties. The role of system approach	L, S
Section 2. Fundamentals of space flight mechanics. The two-body problem	Topic 2.1. The universal gravitation law. Integral equations of motion	L, S
	Topic 2.2. The orbit equation. The velocity of a satellite. Relation between velocity and type of orbit.	L, S

<b>Name of the Course Section</b>	<b>Section Content (subjects)</b>	<b>Type of study*</b>
	Topic 2.3 Characteristics of orbits. The Kepler equation.	L, S
Chapter 3. Perturbed motion of an aircraft	Topic 3.1. General characteristics of perturbation motion and perturbations themselves. General statement of the problem.	L, S
	Topic 3.2. Sphere of action, sphere of attraction, sphere of influence.	L, S
	Topic 3.3. Oscillating elements method.	L, S
	Topic 3.4. Perturbating influences that distort the Keplerian orbit	L, S

## 5. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

*Table 5.1. Classroom equipment and technology support requirements*

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

## 6. RECOMMENDED SOURCES FOR COURSE STUDIES

*Primary literature:*

1. Edited by G.S. Büschgens, Flight Dynamics. Moscow: Mashinostroenie Publisher, 2011. - 776 c.
2. Mechanics of space flight. Under edition of Acad. Mishin V.P. - M.: Mashinostroenie, 1989.
3. Lysenko L.N. Ballistic Missile Guidance and Navigation. - Moscow: Bauman Moscow State Technical University, 2007, 670 pp.
4. Dmitrievsky A.A., Lysenko L.N. External Ballistics. 4th edition. - M: Mechanical Engineering, 2005.
5. Ivanov N.M., Lysenko L.N. Ballistics and Navigation of Spacecraft. 2nd edition. - M: Drofa, 2004.

*Additional literature:*

1. Alekseev K.B., Bebenin G.G., Yaroshevsky V.A. Spacecraft manoeuvring. - Moscow: Mashinostroenie, 1970. - 232 c.
2. Eliasberg P.E. Introduction to the Theory of Flight of Artificial Earth Satellites. - Moscow: Nauka, 1965. - 540 c.
3. Himmelblau D. Applied Nonlinear Programming. - Moscow: Mir, 1975. - 534 c.
4. Herrick S. Astrodynamics. - Moscow: Mir, 1978. - 359c.
5. Sikharulidze Y.G. Ballistics of Aircraft. - Moscow: Nauka, Main Editorial Office for Physical and Mathematical Literature, 1982. - 352 c.
6. Reshetnev M.F., Lebedev A.A., Bartenev V.A., Krasilshchikov M.N., Malyshev V.A., Malyshev V.A., Control and Navigation of Artificial Earth Satellites in Circular Orbits. - Moscow: Mashinostroenie Publisher, 1988. 336c.
7. Solovyov C.V., Tarasov E.V. Predicting interplanetary flights. - Moscow: Mashinostroenie, 1973. - 400 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](http://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 “Dynamics, Ballistics, Control of Motion of Aircraft and Spacecraft”.

\* - 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 "Information Databases for Scientific Research and Publications" 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.

### **DEVELOPER:**

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