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

Academy of Engineering
(educational division (faculty/institute/academy) as programme developer)

DEPARTMENT OF MECHANICS AND CONTROL PROCESSES
(department realizing the PhD program)

COURSE SYLLABUS

Dynamics, ballistics, control of motion of aircraft and spacecraft
(course title)

Scientific specialty:
2.5.16. Dynamics, Ballistics and Control of the Spacecraft and Aircraft Motion
(scientific speciality code and title)

The course instructionis implemented within the PhD programmes:
Dynamics, Ballistics and Control of the Spacecraft and Aircraft Motion
(PhD program title)

2025

1. DISCIPLINE (MODULE) GOAL

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 TO PHD-STUDENTS ON FINISHING 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. WORKLOAD OF THE DISCIPLINE AND TYPES OF 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
Contactacademichours			
Lectures (**L**)		30	30
Lab work (**LW**)			
Seminars (**S**)		30	30
Self-study, ac.h.		*48*	*48*
Evaluation and assessment, ac.h.			
Courseworkload	**ac.h**	**108**	**108**
	cred.	3	**3**

4. CONTENTS CONTENT OF THE DISCIPLINE

Table4.1. Content of the course by type of study

Name of the Course Section	Section Content (subjects)	Type ofstudy*
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. Longitudinalperturbedmotion	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-bodyproblem	Topic 2.1. The universal gravitation law. Integralequationsofmotion	L, S
	Topic 2.2. The orbit equation. The velocity of a satellite. Relation between velocity and type of orbit.	L, S
	Topic 2.3 Characteristics of orbits. The	L, S

Name of the Course Section	Section Content (subjects)	Type ofstudy*
	Kepler equation.	
Chapter 3. Perturbed motion of an aircraft	Topic 3.1. General characteristics of perturbation motion and perturbations themselves. General statementoftheproblem.	L, S
	Topic 3.2. Sphere of action, sphere of attraction, sphere of influence.	L, S
	Topic 3.3. Oscillatingelementsmethod.	L, S
	Topic 3.4. Perturbating influences that distort the Keplerian orbit	L, S

5. EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table5.1. Classroom equipment and technology support requirements

Classroom for Academic Activity Type	Classroomequipment	Specialised training/laboratory equipment, software and materials for the course (if needed)
Lectureroom	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.
Seminarroom	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. METHODOLOGICAL SUPPORT AND LEARNING MATERIALS

Main readings:

1.Edited by G.S. Büschgens, Flight Dynamics. Moscow: Mashinostroenie Publisher, 2011. - 776 c.

2. Lysenko L.N. Ballistic Missile Guidance and Navigation. - Moscow: Bauman Moscow State Technical University, 2007, 670 pp.

3.Dmitrievsky A.A., Lysenko L.N. External Ballistics. 4th edition. - M: Mechanical Engineering, 2005.

4.Ivanov N.M., Lysenko L.N. Ballistics and Navigation of Spacecraft. 2nd edition. - M: Drofa, 2004.

Additional readings:

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:
   - RUDNDLS:http://lib.rudn.ru/MegaPro/Web
   - DLS University library online (in Russian: «Университетскаябиблиотекаонлайн»)http://www.biblioclub.ru
   - DLS“Yurite”(in russian: Юрайт)http://www.biblio-online.ru
   - DLS“Student Advisor”(in Russian: «Консультантстудента»)www.studentlibrary.ru
   - DLS“Troitsky Bridge”(in Russian: «Троицкиймост»)
2. Databaseandsearchengines
   - 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 SCOPUShttp://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. ASSESSMENT TOOLKIT AND GRADING SYSTEM FOR MIDTERM ATTESTATION OF STUDENTS IN THE DISCIPLINE (MODULE)

Assessment toolkit and a grading system to evaluate the level of competences (competences in part) formation as the course results are specified on the TUIS platform.

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

DEVELOPER:

Professor		A.A.Baranov
Position, Department	*Signature*	*Name, Patronymic Name, Surname*
Professor		Yu.N. Razoumny
Position, Department	*Signature*	*Name, Patronymic Name, Surname*

HEAD OF THE DEPARTMENT:

The head of DMCP, Professor		Yu.N. Razoumny
Position, Department	*Signature*	*Name, Patronymic Name, Surname*