Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Кафедра
Систем керування
літальними апаратами

Navigation and robotic systems and complexes

Work program of the discipline (Syllabus)

Details of the discipline	
Level of higher education	***Third (educational and scientific)***
Field of knowledge	*Electronics and telecommunications*
Specialty	*173 Avionics*
Educational program	*Control systems of flight vehicles and complexes engineering*
Discipline status	*Normative*
Form of study	*full-time (day) / full-time (evening) / part-time*
Year of preparation, semester	*2nd year, spring semester*
The scope of discipline	*6 credits (180 hours)*
Semester control / control measures	*examination*
Timetable	*Rozklad.kpi.ua*
Language of teaching	*English*
Information about course leader / teachers	Lecturer: Doctor of Technical Sciences, Professor Oleksandr Vasyliovych Zbrutsky, tel. + 044-2048224, e-mail: zbrutsky@cisavd.kpi.ua Practical / Seminar: doctor of technical sciences, professor Zbrutsky Olexandr Vasyliovich, tel. + 044-2048224, e-mail: zbrutsky@cisavd.kpi.ua
Course placement	Sikorsky platform

Curriculum of the discipline

Description of the discipline, its purpose, subject of study and learning outcomes

Discipline "Navigation and robotic systems and complexes" forms theoretical and practical knowledge of students in the development of navigation and robotic systems, basic principles of design of navigation and robotic systems of different classes and purposes, provides the ability to master modern technologies of navigation and robotic systems.

Students learn the methodology and technology of application of various principles and approaches in the design of navigation and robotic systems, gain experience in correctly determining the parameters of systems to implement the required specifications of navigation and robotic systems, taking into account the features of their application and capabilities of modern modeling software.

1. The purpose and objectives of the discipline

1.1. The purpose of the discipline is the formation of graduate students the following abilities in accordance with the educational and scientific program:

- Ability to abstract thinking, analysis and synthesis (ZK01);
- Ability to search, process and analyze information from various sources (ZK02);
- Ability to perform original research, achieve scientific results that create new knowledge in the field of avionics and related interdisciplinary areas and can be published in leading scientific journals in avionics and related fields (FC01);
- Ability to use modern information technologies, databases and other electronic resources, specialized software in scientific and educational activities (FK02);Have a systematic scientific worldview and general cultural outlook (ZC08);
- Ability to develop models, methods and algorithms for controlling aviation, space, robotics and other mobile automatic or automated objects FK04);
- Ability to develop models, methods and technologies for diagnosing, maintenance and repair of avionics systems and complexes (FC05).

1.2. The main tasks of the discipline.

According to the requirements of the educational and scientific program, postgraduate students after mastering the discipline must demonstrate the following knowledge and skills:

- Advanced conceptual and methodological knowledge in avionics and on the borders of subject areas, sufficient for conducting scientific and applied research at the level of the last 6 world achievements in the relevant field, gaining new knowledge and / or implementing innovations (ZN1).
- Develop and research conceptual, mathematical and computer models of processes and systems, effectively use them to gain new knowledge and / or create innovative products in the field of aircraft control systems (UM1).

-Implement on the basis of research software and hardware and application packages for the design of control systems for aerospace and rocketry (UM3).

- To develop and analyze new algorithms for the operation of aerobatic navigation systems of aircraft in conditions of uncertainty and incompleteness of a priori information (UM4).

- Carry out analysis of existing and synthesis of new methods and models for diagnosing control systems (UM5).

Prerequisites and post-requisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)

To master the discipline "Navigation and robotic systems and complexes" requires knowledge and skills that students will acquire during the study of disciplines of the second (master's) level of training in specialty 173 "Aircraft control systems and

complexes": Aircraft control systems (PO1), Systems pattern recognition (PO3), Orientation systems of moving objects (PO4), Scientific work on the topic of master's dissertation (PO5).

The knowledge and skills that graduate students acquire in the process of studying the discipline "Navigation and robotic systems and complexes" are the basis for the formation of the dissertation of Doctor of Philosophy in the specialty 173 Aivionics.

The content of the discipline

Table 1

Names of sections and topics	Number of hours				
	Total	including			
		Lectures	Practical	laboratory	IWS
Topic 1. Definition of navigation and robotic systems and complexes. Classification of navigation and robotic systems and complexes. Examples of navigation and robotic systems and complexes. Remotely controlled robotic complexes. Autonomous robotic complexes.	32	4	-	-	27
Topic 2. Navigation systems and complexes of moving objects. Types of navigation systems and complexes. Their characteristics. Principles of construction of navigation systems and complexes. Autonomous and integrated navigation systems and complexes. Ways to increase the accuracy of autonomous navigation systems and complexes. Ways to increase the accuracy of integrated navigation systems and complexes.	64	2	2	-	31
Topic 3. Concepts of construction of modern robotic systems and complexes. Ground robotic complexes. Air robotic complexes. Ways to implement the concepts of building robotic systems and complexes.	32	2	2	-	18
Topic 4. Basic requirements for subsystems of ground and air robotic complexes.	22	2	-	-	20
Calculation work	40	-	-	-	40
Examination	30	-	-		30
Total Hours	180	10	4		166

Training materials and resources

Basic literature:

1.Н.В. Морзе, Л.О. Варченко-Троценко, М.А. Гладун, Основи робототехніки: навчальний посібник / Н.В. Морзе, Л.О. Варченко- Троценко, М.А. Гладун. – Кам’янець-Подільський : ПП Буйницький О.А., 2016. – 184 с.

2.Д. Крейг Введене в робототехнику. Механика и управление. Изд-во Институт компьютерных исследований, 2013. – 564 с

3.Хомченко В.Г. Робототехнічні системи. Навч.пібник. Вільнюс.:2016.- 160с.

Additional literature:

1.Смирнов А.Б. Мехатроника и робототехника. Системы микроперемещений с пьезоэлектрическими приводами; Учеб. пособие. СПб.: Изд-во СПбГПУ, 2003. 160 с

Educational content

Methods of mastering the discipline (educational component)

Lectures

Table 2

№	The title of the lecture topic and a list of key issues
1	Lecture 1. Definition of navigation and robotic systems and complexes. Classification Remotely controlled robotic systems. Autonomous robotic complexes. Literature: [base: 1,3] Tasks on IWS. Examples of robotic systems and complexes. TTC of remotely controlled robotic complexes of the EU countries.
2	Lecture 2. Navigation systems and complexes of moving objects. Types of navigation systems and complexes. Their characteristics. Principles of construction of navigation systems and complexes. Autonomous and integrated navigation systems and complexes. Ways to increase the accuracy of autonomous navigation systems and complexes. Ways to increase the accuracy of integrated navigation systems and complexes. Literature: [base: 2] Tasks on IWS. Examples of navigation systems and complexes. TTC of navigation complexes of the EU countries.
3	Lecture 3. Concepts of construction of modern robotic systems and complexes. Ground robotic complexes. Air robotic complexes. Ways to implement the concepts of building robotic systems and complexes. Literature: [base: 1,3] Tasks on IWS. Examples of robotic systems and complexes. TTC of remotely controlled robotic complexes of the EU countries.
4	Lecture 4. Combined robotic complexes. Ways of realization of concepts of construction of the combined robotic systems and complexes. Literature: [base: 1,3] Tasks on IWS. Examples of combined robotic systems and complexes.
5	Lecture 5. Basic requirements for subsystems of ground and air robotic complexes. SLAM-technologies Literature: [base: 1] Tasks on IWS. SLAM algorithms and their development

Practical training

The main purpose of practical classes is to master the directions and methods of development of navigation and robotic complexes set out in lectures.

Table 3

№	The name of the topic of the practical lesson	Hours
1	Ways to increase the accuracy of navigation systems and complexes	2
2	Ways to implement concepts for building robotic systems and complexes	2

Policy and control

Independent work of a graduate student

Independent work of a graduate student (IWS) consists in preparation for classroom classes, acquaintance with thematic literature, performance of independent works. The volume and topics of independent work of graduate students are given in Table. 2.

Individual tasks

The individual task of the credit module "Navigation and robotic systems and complexes" is performed in the form of home control work.

The main objectives of the home control work are to obtain in-depth knowledge and practical experience in the application of design methods, increase the reliability of modern avionics and robotics systems.

Course policy (educational component)

Grading policy (missed classes, passing of passes): each grade is given in accordance with the criteria developed by the teacher and announced in advance to graduate students, and is motivated individually at the request of the graduate student; in case the graduate student does not complete all the planned classes, he is not allowed to take the exam; missed classes must be completed. The form and time of work are coordinated by the graduate student and the teacher.

Policy of academic behavior and integrity (plagiarism, behavior in the audience): conflict situations should be openly discussed in academic groups with the teacher, it is necessary to be mutually tolerant, to respect the opinion of others. Plagiarism and other forms of dishonest work are not allowed. Inadmissible tips and write-offs during seminars, tests, exams.

Norms of academic ethics: discipline; observance of subordination; honesty; responsibility; work in the classroom with disconnected mobile phones.

Types of control and rating system for evaluation of learning outcomes (RSE)

The following methods and forms of control are used to effectively check the level of mastering by students of higher education of knowledge, skills and abilities in the discipline:

- method of oral control: main questions, additional, auxiliary; questions in the form of a problem; individual, face-to-face and combined surveys;

- method of written control;

- test control method;

- practical control.

Current control is carried out at each practical lesson in accordance with the specific objectives of the topic in order to check the degree and quality of learning. All classes use objective control of theoretical training and practical skills. In the process of current control, the student's independent work on the completeness of tasks, the level of assimilation of educational materials, mastering practical skills of analytical, research work, etc. is evaluated.

The results of the current control are entered into the Igor Sikorsky KPI Campus System.

Final control - control of educational achievements of higher education students in order to assess the quality of their mastery of the curriculum, which is conducted during the semester certification in the form of an exam. The purpose of the final control is to identify
mastering the discipline in general, understanding the educational material, the relationship of the content of educational material, the logic of its assimilation, etc.
The final control is carried out in the form of an examination in accordance with the educational program, the individual plan of the applicant for higher education and the working curriculum, developed on the basis of the ONP specialty. At this stage the result of studying and mastering of discipline, skills of use of the received knowledge is summed up.

The final control in the form of an exam is carried out according to the schedule of the credit-examination session.
The results of the final control are entered into the Igor Sikorsky KPI Campus System.
Postgraduate students who have completed the curriculum and scored at least the minimum number of points are admitted to the final control. A graduate student who, for a good reason, had missed classes, adjustments are made to the individual curriculum and are allowed to work off academic debt until a certain date.

Final control is carried out in a mixed form - written and oral and includes control of theoretical and practical training.
The rating of the applicant for higher education in the discipline is calculated based on a 100-point scale, of which 56 points is the starting scale. The starting rating (during the semester) consists of points that the student receives for:
- work in practical classes;
- performance of settlement work.

Scoring criteria:
Work on practical classes:
- active creative work - 3 points;
- fruitful work - 2 points;
- passive work -0 points.

Execution of settlement work:
- the work is written flawlessly - 50 points;
- the work was performed with minor shortcomings - 45 points;
- the work was done with certain errors -35 points:
- the work is not credited (the task is not completed or there are gross errors) - 0 points.
At the exam, applicants for higher education perform a written test. Each task contains one theoretical question (task) and one practical one. Each question (task) is evaluated in 23 points according to the following criteria:
- "excellent", complete answer, not less than 90% of the required information, performed in accordance with the requirements for the level of "skills" (complete, error-free problem solving) - 21-23 points;
- "good", a sufficiently complete answer, not less than 75% of the required information, performed in accordance with the requirements for the level of skills or there are minor inaccuracies (complete solution of the problem with minor inaccuracies) - 17-20 points;

- "satisfactory", incomplete answer, not less than 60% of the required information, performed in accordance with the requirements for the "stereotypical" level and some errors (the task is performed with certain shortcomings) - 13-16 points;
- "unsatisfactory", the answer does not meet the conditions for "satisfactory" - 0 points.
The sum of starting points and points for credit test work is transferred to according to the table:

Table 4 correspondence of rating points to grades on the university scale:

Scores	*Rating*
100-95	Perfectly
94-85	Very good
84-75	goode
74-65	satisfactory
64-60	Enough
Less 60	Unsatisfactorily
Admission conditions are not met	Not allowed

Additional information on the discipline (educational component)

Since this discipline belongs to the modern ones, in order to increase the efficiency of its teaching, materials in the form of presentations of the leading enterprises of Ukraine in the field of navigation systems and robotic systems are used along with traditional teaching methods.

Work program of the discipline (syllabus):

Compiled by Professor, D.T.S. Zbrutsky Olexandr Vasyliovich

Approved by the Department of CSFV (protocol № 16 of 12.05. 2021)

Approved by the Methodical Commission of IAT (protoco № _ of __.__.2021)