Ministry of Education and Science of Ukraine

National Aerospace University

"Kharkiv Aviation Institute"

Department of Aircraft Control Systems (Dep. 301)

APPROVED:

Guarantee of the educational program

A.Kulik

" 27 " 68 _____2021

WORK PROGRAM OF THE COMPULSORY DISCIPLINE

FUNDAMENTALS OF NAVIGATION
(COURSE WORK)

Field of Study: 17 – Electronics and Telecommunication

Program Subject Area: 173 – Avionics

Educational Program: Systems of Autonomous Navigation
and Adaptive Control of Aircrafts

Level of Qualification: 1st (bachelor degree)

Kharkiv 2021

The developed study program of compulsory discipline «Processes Control in Condition of Uncertainty» is for English-speaking students of training direction 173 − Avionics

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Developer: K.Yu. Dergachov, Associate professor of the department 301, Candidate of science (Engineering)

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(sign)

The program has been examined at the meeting of dep. 301 «Aircraft Control Systems».

Record of proceeding: № 1 from " 27 " August 2021

Head of the department
Associate professor, PhD (Engineering) _____ K.Yu. Dergachov
(sign)

1. Course description

Indices	Field of study, Program subject area, educational programl	Course specification
		Full-time study
ECTS credits – 2	Branch of Education: 17 – Electronics and Tele-communication	Professional training subject
Modules – 1		Calendar year
Semantic modules – 1		
Individual Assignment	Program subject area: 173 – Avionics	2021-2022
		Semesters
		5
Total hours – 60	Educational Program: Systems of Autonomous Navigation and Adaptive Control of Aircrafts	Lectures [1]
Academic hours per day for full-time study		0
Semester 5		Tutorial classes [1]
contact (in class) 1 hrs. / self-study 2.75 hrs.		16
	Level of qualification: 1st (bachelor degree)	Self-study work
		44 hrs.
		Assessment form
		Deferential pass

[1] depending on timetable, classroom studies can decrease or enlarge by one hour in a week

Note: ratio of classroom working and unaided (self-study) work makes:

16/44 (under full-time education).

2. Purpose and objectives of academic discipline

Learning Aims – studying methods and systems that allow you to determine the location of moving objects and determine rational traffic routes.

Training objectives – the study of navigation concepts and terms, theories, methods, and algorithms that solve the practical tasks of determining the location and determine the rational directions of the movement.

Learning Outcomes

On successful completion of the subject, students **should know**:

- basic coordinate systems and algorithms for converting coordinate systems;

- methods of determining the location of moving objects;

- methods for determining rational traffic routes;

- types and features of the construction and operation of modern and classic navigation systems.

should be able to:

- define their own coordinates in different coordinate systems and perform their transformation;

- determine the routes of rational movement of moving objects;

- use satellite navigation tools to solve practical navigation tasks.

3. Content of the course

Module 1

Semantic Modulus 1. Determining user's location using iterative method

Topic 1. Theoretical part.

The theoretical part includes an analytical presentation of the material on a given topic.

Topic2. Practical part.

Practical part includes recording navigation and observation messages of RINEX format, receiving an information about satellites' coordinates and pseudo-ranges, calculating users position, accuracy of calculations and DOPs, conclusions,

build the location of satellites relative to the observer in Cartesian and polar coordinate system.

Receive the navigation and observation messages of RINEX format using the procedure of Laboratory work № 1 of last semester.

Using Novatel software, perform a measurement of navigation satellite movement. Add measurements to table. You need to registered data every 5 minutes. You have to register 10 measurements.

Add to pseudo-ranges that are used to solve navigation tasks equal increments (using w - Coefficient of the artificial errors in the pseudorange). Execute the file. Analyze and explain the results. Record the data in the report.

4. Course structure

Semantic modules and topics	Hours									
	full-time					part-time				
	total	among them								
		lec	pr	lab	indep					
1	2	3	4	5	6	7	8	9	10	11
Module 1										
Semantic Modulus 1 – Determining user's location using iterative method										
Topic 1. Theoretical part.	28	–	–	6	22	–	–	–	–	–
Topic 2. Practical part.	32	–	–	10	22	–	–	–	–	–
Total for semantic modulus 1	60	–	–	16	44	–	–	–	–	–
Course total	60	–	–	16	44	–	–	–	–	–

5. Topics of tutorial

№ a/o	Topic name	Hours
1	Theoretical part.	6
2	Practical part.	10
	Total	**16**

6. Self-study (unaided works)

№ a/o	Topic name	Hours
1	Includes an analytical presentation of the material on a given topic in a volume of 10-12 pages	22
2	Recording navigation and observation messages of RINEX format, receiving an information about satellites' coordinates and pseudoranges, calculating users position, accuracy of calculations and DOPs, conclusions, build the location of satellites relative to the observer in Cartesian and polar coordinate system	22
	Total	**44**

7. Teaching methods

Lectures delivering, conducting lab classes, individual consultations (if necessary), independent work of students with tutorials issued by the department (learning the manuals). Conducting classroom lectures, individual consultations, individual students work on materials published by the Department, participation in conferences and competitions.

8. Forms of control

Current test points that score submitted lab reports and individual assignments, evaluation (grades) of semantic topics, final examination.

9. Appointment of grade points obtaining by a student (credit points)

Current tests and unaided work								Summative test (examination) due to refusing the received current points and intent taking the exam if allowed
Semantic Modulus №1	Semantic Modulus № 2	Semantic Modulus №3	Semantic Modulus №4	Semantic Modulus №5	Semantic Modulus №6	Semantic Modulus №7	Sum	
T2	T3	T4	T6	T7	T8	T9		
10	10	10	20	20	20	20	100	100

10. Assessment criteria and points distribution that students receive

10.1. Points distribution that students receive

5 semester

Components of educational work	Marks per lesson (task)	Number of lessons (tasks)	Total marks
Semantic Module 1			
Lectures work	0…0	0	0…0
Execution and protection of theoretical part	0...5	3	0...30
Execution and protection of practical par	0..5	5	0..10
Defending course work	0..20	1	0..20
Total for the semester			60…100

The exam ticket consists of theoretical and practical questions. Example.

Theoretical questions:

Geonavigational information: the shape of the Earth, the motion of the Earth, the main geographic points, lines and circles of the globe, geographic latitude and longi-

tude, directions on the earth's surface, orthodrium, loxodromic. Earth coordinate systems: geographic, orthodrium, rectangular, polar and their relationship

Practical questions:

1. The concept of the exchange protocol. Protocol NMEA 0163, Binary, Novatell. Formation of data of navigation satellites and data executed by the consumer receiver in standardized formats. Data structure of various satellite navigation systems.

2. Principles of construction monitoring systems. Application of monitoring data to assess the accuracy, integrity, continuity of service and ex-operational availability of satellite navigation systems.

10.2. Qualitative evaluation criteria

Knowledge required for positive evaluation: knowledge in digital signal processing and sufficient programming skills in the MATLAB environment, which provides great opportunities for efficient signal and designing systems for automatic detection of moving objects. Investigation separate elements of the system during the course work.

Required skills for positive evaluation: Be able to use: Methods for analyzing video data (saved as a file or obtained directly from your camcorder) using Image Processing Toolbox, Computer Vision System Toolbox in Simulink, and Image Acquisition Toolbox.

10.3. Criteria for evaluating student work during the semester

1. Excellent (90 ÷ 100 points) is presented to the student:

1.1 Who knows firmly: the basic concepts and principles pertaining to the discipline of uncertainty management. Has defended all practical, laboratory and individual tasks, completed all modular tasks with a rating of "excellent", has solid practical skills in circuit design. Freely uses the educational and scientific literature on the subject of discipline. He can logically and clearly form his answer, solve practical and laboratory tasks.

1.2 A reduction in the number of points within the assessment is possible with inaccurate wording in the answers to the additional questions posed to it.

2. Good (75 ÷ 89 points) is presented to the student:

2.1 Having sufficient knowledge of the theoretical part of the discipline. Defended all practical, laboratory and individual tasks, completed all modular tasks with a rating of "good", has practical skills in circuit design. Correctly solves practical tasks, its answers are not clear.

2.2 A reduction in the number of points within the assessment is possible if the theoretical or practical questions are not fully answered

3. Satisfactory (60 ÷ 74 points) is presented to the student:

3.1 Who has weak theoretical knowledge, has a minimum of knowledge and skills, makes mistakes in solving practical problems. Has defended all practical, laboratory and individual tasks, completed all modular tasks, has unsure practical skills in circuit design.

3.2 A reduction in the number of points within the assessment is possible due to inaccurate and incomplete answers to theoretical and practical questions.

Grading scale: national and ECTS

Total marks	National validation grade	
	Exam	Pass
90 – 100	excellent	pass
83 – 89	good	pass
75 – 82	good	pass
68 – 74	satisfactory	pass
60 – 67	satisfactory	pass
1 – 59	unsatisfactory	no pass

11. Recommended reading

Basic

1. Air navigation [Text] / U.S. Department of transportation, Federal Aviation Administration, Airman Testing Branch, – Oklahoma city, 2004. – 288 p.

2. Hofmann-Wellenhof B., Lichtenegger H., Wasle E. Global Navigation Satellite Systems [Text] / Hofmann-Wellenhof B., Lichtenegger H., Wasle E.– Austria, 2008 . – 546 p.

3. Bose A., Bhat K. N., Kurian T. Fundamentals of navigation and inertial sensors[Text] / A. Bose, K. N. Bhat, T. Kurian – Delhi, 2014 . – 425 p.

4. Walper, J. Mathematical notions for navigational aircraft [Text] / J. Walper – McGraw-Hill Education, 2001 . – 358 p.

5. Trewor, T. Air navigation [Text] / T. Trewor – Publisher Ltd, 2003 . – 512 c.

6. Bore, F. Fundamentals of Radio Navigation [Text] / F. Bore – Prentice Hall, 1991. – 392 p.

Complementary reading

1. Dempsey, P. Laws of Air Navigation [Text] / P. Dempsey – Springer Science & Business Media, 2012 . – 270 p.

2. Mohinder, S. Greouol, A., Andrews, P., Barton, K., Global Navigation Satellite System, Inertial Navigation and Integration [Text] / S., Mohinder, A. Greouol, P. Andrews, K. Barton, – Inc. Published by John Wiley & Sons, Inc., 2013 . – 561 p.

12. Information resources

Department's site: k301info