TITLE OF THE Curricula/Module

SATELLITE NAVIGATION SYSTEMS

KATU /Kazakhstan

2021

1. DATA ABOUT LECTURER

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2. DISCIPLINE DATA

The discipline "Satellite navigation systems" is an integral component of module 11 - Scientific direction. The number of credits is 2, the number of lectures is 15, the number of practical classes is 15, the semester is 7, the place of the classes is the audience of the land management faculty.

DISTRIBUTION OF LEARNING TIME

Weeks of the semester	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Lectures	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Practical classes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
IWSL (independent work of students with a lecturer)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
IWS (independent work of students)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	45
Total	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	90

3. PREREQUISITES OF THE COURSE

Courses of disciplines preceding the study of this discipline: higher mathematics, geodesy, higher geodesy.

The list of disciplines containing knowledge, abilities and skills necessary for mastering the discipline under study: physics, radio electronics and radio engineering.

4. POST-REQUESITES OF THE COURSE

The knowledge acquired by students on satellite navigation systems will be necessary when performing topographic and geodetic works in production

5. BRIEF DESCRIPTION OF THE COURSE

The course "Satellite navigation systems" is designed for students with basic training in general physics, higher mathematics, fundamentals of radio electronics (theory of circuits and signals, electrodynamics and propagation of radio waves, antenna feeder devices, analog and digital electronics, radio automation devices). The main attention is paid to studying: principles of building systems and equipment for satellite navigation consumers, functional additions to satellite navigation systems; modern methods of navigation-time determination (NVO) and signal processing in satellite radio navigation systems; the use of satellite navigation technologies for solving applied problems.

The purpose of mastering the discipline "Satellite navigation systems" is the formation of general cultural and professional competencies in the field of global and local satellite systems: GPS, GLONASS, systems of other countries, the principles of their orbital construction and functioning, their practical application for navigation positioning systems, modern electronic equipment and technologies its use in various areas of the economy.

Objectives of the discipline - mastering the ways, methods and technology of using satellite equipment and apparatus.

A student who has studied this course should know: the principles of building systems and equipment for consumers of satellite navigation, functional additions to satellite navigation systems, modern methods of navigation-time definitions (NTD) and signal processing in satellite radio navigation systems, the use of satellite navigation technologies for solving applied national economic and defense tasks.

Upon completion of the course, the student must be able to: apply in practice modern satellite equipment and apparatus.

6. COURSE CONTENT

6.1 List of lectures

Topic name	Hours	Literature	Week	Current control, 50/100 score (for each task)
1	2	3		4
	Midterm control 1			
1. Subject and objectives of the discipline. General tasks of navigation and satellite navigation. The role of radio navigation in solving national economic and defense problems. Navigation coordinate systems. Time scales.	1	ОЛ 1, 9 ДЛ 1	1,2	50/100
2. Methods of IEE in SRNS Rangefinder, pseudo-range, differential-rangefinder method of navigation definitions. Doppler and pseudo-Doppler and Doppler difference methods.	2	ОЛ 1 ДЛ 1, 4	3,4	50/100
3. Satellite navigation system GLONASS. Orbital constellation. Ground segment. Ephemeris provision. Time-frequency support, navigation messages GLONASS. The structure of active and prospective signals in the SRNS.	2	ОЛ 9, 10 ДЛ 7	5,6	50/100
4. GPS satellite navigation system. General structure of the system. Orbital and ground segments. Time-frequency support, GPS navigation messages. Structure of active and prospective GPS signals.	2	ОЛ 4, 7 ДЛ 6	7,8	50/100
	Midterm control 2			
5. Satellite navigation system GALILEO. Orbital constellation; ground segment. ephemeris and time-frequency support, navigation messages GALILEO. Signal structure.	2	ОЛ 2, 7, 8 ДЛ 1, 2, 7	9,10	50/100

6. Improving the accuracy and reliability of satellite measurements. Time-navigational definitions based on phase measurements. Phase measurement ambiguity resolution. Determination of the spatial orientation of objects. Trajectory filtering algorithms.	2	ОЛ 4, 9 ДЛ 6, 7	11	50/100
7. Differential methods in the SRNS. Differential and relative NVO mode. Formation of time-frequency corrections in local and wide-gap differential systems. Wide-area differential systems SDKM, WAAS, EGNOS, MSAS.	2	ОЛ 7 ДЛ 1, 8	12,13	50/100
8. Problem of noise immunity of consumer equipment SRNS. Improving the noise immunity of the NAP by the methods of optimal signal processing, space-time processing and integration with inertial navigation systems.	2	ОЛ 2, 7, 8 ДЛ 1, 2, 6	14,15	50/100
Total lecture classes	**15**			50/100

6.2 List of practical classes

Topic name	Hours	Literature	Week	Current control, 50/100 score (for each task)
1	2	3		4
	Midterm control 1			
Practical lesson 1 Re-calculating rectangular coordinates from one six-degree zone to another six-degree zone (from east to west or from west to east)	2	ОЛ 2, 3, 4 ДЛ 6, 8	1,2	50/100
Practical lesson 2 Converting rectangular coordinates from a six-degree zone to a three-degree zone and vice versa	2	ОЛ 2, 3, 4 ДЛ 6, 7	3,4	50/100
Practical lesson 3	2	ОЛ 7,8	5,6	50/100

Converting the coordinates of points from one plane coordinate system to another		ДЛ 1		
Practical lesson 4 Calculation of the length of the line reduced to the physical surface of the Earth.	2	ОЛ 7,8 ДЛ 1	7,8	50/100
Midterm control 2				
Practical lesson 5 Determining the coordinates of a point by three measured distances from three known points	2	ОЛ 2, 3, 4 ДЛ 6, 7	9,10	50/100
Practical lesson 6 Acquaintance with the configuration and technical characteristics of the satellite equipment used for geodetic purposes	1	ОЛ 2, 3, 4 ДЛ 6, 7	11	50/100
Practical lesson 7 Study of the set of equipment and instructions for working with a satellite receiver	2	ОЛ 2, 3, 4 ДЛ 6, 7	12,13	50/100
Practical lesson 8 Preparation for work and initial launch of the satellite receiver	2	ОЛ 2, 3, 4 ДЛ 6, 7	14,15	50/100
Total	15			50/100

7. SCHEDULE OF PERFORMANCE AND DELIVERY OF THE SRS TASKS FOR THE DISCIPLINE

№ п/п	Topic	Tasks of IWS	Purpose and content of tasks	Recommended literature	Form of control	Deadline	Current control, 50/100 score (for each task)
1	2	3	4	5	6	7	8
1		Work No. 1 Classification of radio navigation systems (RNS) and methods of solving problems of optimal signal reception.	Mastering radio navigation systems and methods of receiving signals	ОЛ 2, 3, 4 ДЛ 6, 8	Individual delivery	1 неделя	50/100
2		Work No. 2 Detection of radio navigation signals and their assessment parameters.	Classification of tasks for estimating signal parameters. Quality indices and criteria of optimality of signal parameters estimation.	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	2 неделя	50/100
3		Work No. 3 Range measurement methods in RNS.	Pulse measurement method range. Phase method for measuring range. Frequency ranging method	ОЛ 7,8 ДЛ 1	Individual delivery	3 неделя	50/100
4		Work No. 4 Methods for measuring the radial velocity in the RNS.	Methods and devices frequency measurement of radial velocity. Joint dimension range and speed by the frequency	ОЛ 7,8 ДЛ 1	Individual delivery	4 неделя	50/100

			method.				
5		Work No. 5 Methods and devices for radio direction finding.	Methods for measuring angular coordinates. Phase method of working direction finding. Amplitude radio direction finding methods.	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	5 неделя	50/100
6		Work number 6 Study of the dependence of characteristics RNS from interference power.	Study of the dependence of the probability of detection signal from interference power. Study of the dependence of accuracy measuring the navigation parameter of the signal from the interference power.	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	6 неделя	50/100
7		Work No. 7 Legal regulation of the use of satellite navigation systems	Normative legal documents governing the change of satellite navigation systems.	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	7 неделя	50/100
Test No. 1. Solving test tasks of varying complexity individually Maximum score - 100							
8		Work number 8 The basic principles of building radio navigation systems stem.	The principles of construction and operation of the RNS. Classification and technical characteristics of RNS. Radio navigation methods.	ОЛ 2, 3, 4 ДЛ 6, 8	Individual delivery	8 неделя	50/100

9		Work No. 9 Satellite radio navigation systems.	General principles of construction and operation of satellite RNS. Composition, purpose and principle of operation of the ground station equipment (monitoring and control subsystem).	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	9 неделя	50/100
10		Work No. 10 Satellite radio navigation system GLONASS.	Structure and main characteristics. Deployment stages. Coordinate system used in the GLONASS SRNS	ОЛ 7,8 ДЛ 1	Individual delivery	10 неделя	50/100
11		Work No. 11 Multi-satellite low-orbit communication system "Gonetz ".	Purpose, composition, basic services of MNSS "Gonets". System structure. Organization of communication in the system. Types and technical characteristics of subscriber equipment (terminals).	ОЛ 7,8 ДЛ 1	Individual delivery	11 неделя	50/100
12		Work No. 12 Foreign satellite radio navigation systems	SRNS GPS - composition, main technical characteristics, services provided. SRNS GALILEO - composition, main technical characteristics, services provided. SRNS COMPASS (Beidou) - composition, main technical characteristics, services provided	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	12 неделя	50/100

13		Work No. 13 Consumer navigation equipment.	Principles of building consumer equipment. Personal navigation equipment. Navigation equipment for land transport. Radio stations with GLONASS / GPS support.	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	13 неделя	50/100
14		Work No. 14 Monitoring systems.	Types of monitoring systems Main functions and tasks	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	14 неделя	50/100
15		Work No. 15 Monitoring of moving objects	Types of transport monitoring systems. Main functions and tasks	ОЛ 2, 3, 4 ДЛ 6, 7	Individual delivery	15 неделя	50/100
Test No. 2. Solving test items of varying complexity individually Maximum score 100							

8. LIST OF REFERENCES

1. Interface control document. Navigation radio signal in the L1, L2 bands with open access and frequency division (revision 5.1) - Moscow: RNIIKP, 2008. - 74 p.
2. Koretskaya, GA Modern electronic-optical geodetic equipment and satellite navigation systems [Electronic resource]: a textbook for students of the specialty 130402 "Mine surveying" / comp. G.A. Koretskaya;
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4. Poklad, GG Geodesy: textbook. manual for universities / G. G. Poklad, S. P. Gridnev. - M .: Akademicheskiy prospect, 2008. –592 p.
5. Koretskaya, GA Satellite navigation systems in mine surveying: textbook. allowance / GA Koretskaya; KuzGTU. - Kemerovo, 2012 .-- 94 p.
6. Avakyan, VV Applied geodesy: Geodetic support of construction production / VV Avakyan. - M .: Vuzovskaya kniga, 2011 .-- 256 p.
7. Antonovich, KM The use of satellite radio navigation systems in geodesy. In 2 volumes.Vol. 1 / K.M. Antonovich. - M .: FSUE "Kartotsentr", 2005. - 344 p.
8. Antonovich, KM The use of satellite radio navigation systems in geodesy. In 2 volumes. T. 2 / K. M. Antonovich. - M .: FSUE "Kartotsentr", 2006. - 360 p.
9. Genike, A.A. Global satellite positioning system GPS and its application in geodesy / AA Genike [et al.]. - M .: Kartgeocenter, 1999.-272 p.
10. Boyko V.V., Savinkov V.M. Designing databases of information systems. - M .: Finance and statistics, 1989 .-- 351 p.
11. Konin, V.V. Satellite systems and technologies. - M .: ICC "Akademkniga", 2001. - 245 p .: ill.
12. Rinex 3.0 format. ftp://epncb.oma.be/ [electronic resource].
13. Manual for the installation and management of the OEMV family. (OEMV Family. Installation & Operation Manual. 10 revision Level) // OM-20000093. - 2009.
14. Global navigation satellite system GLONASS. Interface control document. - Ed. 5.1. M .: RNII KP, 2008.
15. Interface Specification: Navstar GPS Space Segment / Navigation User Interfaces (IS-GPS-200). - R. E. CA: Science Applications International Corporation, 2010.
16. RTCM Recommended Standards 10402.3 for Differential GNSS (Global Navigation Satellite Systems) Services - Version 2.3, 2001.
17. RTCM Recommended Standards 10403.1 for Differential GNSS (Global Navigation Satellite Systems) Services - Version 3.1, 2006.
18. Guidelines for EPN Stations & Operational Centers, 2007, - 33 p.
19. Guidelines for New and Existing Continuously Operating Reference

Stations. National Geodetic Survey. 2006, - 14 p.

List of additional literature

1. Kaganov V.I. Fundamentals of radio electronics and communications: a tutorial /
2. V.I. Kaganov, V.K. Bityukov. - M .: Hot line - Telecom, 2007. - 542s.
3. Radio engineering systems / Yu.P. Grishin, V.P. Ipatov, Yu.M. Ka-
4. sarinov and others; Ed. Yu.M. Kazarinova. - M .: Higher school, 2000 .-- 496s.
5. Antenna feeder devices and radio wave propagation:
6. Textbook for universities / G.A. Erokhin, O. V. Chernyshev, N. D. Kozyrev, V.G. Kocherzhevsky; ed. G.A. Erokhin. - M .: Hotline-Telecom. 2004. — 491 s.

9. COURSE POLICIES

1. Do not be late for class
2. Timely carry out practical work
3. Turn off mobile phones during class
4. Comply with the internal regulations of the university

10. INFORMATION ON KNOWLEDGE ASSESSMENT

When setting the final exam grade in a subject, the score received on the exam and the average grade of the current academic performance during the semester are taken into account. Weight shares in the final grade: 1/3 are the results obtained at the exam, 1/3 are the results of current control and 1/3 are the results of intermediate control.

10. EVALUATION POLICY

The maximum score is 100, the minimum score is 50.
Lectures:
Presence 75
Active participation +25
Receiving comment -25

LPC:
Completing task 75
High-quality execution +25
Poor performance -25

IWS:
Completing task 75
High-quality execution +25
Poor performance -25

DISCIPLINE KNOWLEDGE ASSESSMENT SCHEME

Form of control	Types of classes and students' work	Amount of score min/ max
1	CURRENT CONTROL: Lecture: LPC: IWS:	 50 / 100 50 / 100 50 / 100
	Total (average)	50 / 100
2	INTERMEDIATE CONTROL:	

	Midterm control 1 Midterm control 2	50 / 100 50 / 100
	Total (average)	50 / 100
3	Final control: Exam	 50 / 100
	Total (average)	50 / 100

SCHEME OF THE KNOWLEDGE ASSESSMENT OF STUDENTS AT THE EXAM

	Exam score	Assessment in score (for each completed task)
1	Current control Mid- term control	50 / 100 50 / 100
2	Final control	50 / 100
3	Total (average):	50 -100

STUDENT KNOWLEDGE ASSESSMENT SCALE

Literal assessment Literal	Digital equivalent	% Content	Traditional system
A	4,0	95-100	***excellent***
A -	3,67	90-94	
B +	3,33	85-89	***good***
B	3,0	80-84	
B -	2,67	75-79	
C +	2,33	70-74	***satisfactory***
C	2,0	65-69	
C -	1,67	60-64	
Д +	1,33	55-59	
Д	1,0	50-54	
F	0	0-49	***unsatisfactory***