Recommended
at the meeting of the Department of Automation and Computer Remote Control of Train Traffic

protocol № 9 dated 04.07.2022

SYLLABUS

from the discipline **«Signal autoregulation systems»**

Semester and year of study:	***I semester, first year of study***
Educational level:	***second (master's)***
Branch of knowledge	***15 – Automation and instrumentation***
Code and name specialty	***151 Automation and computer-integrated technology***

Lectures, practical classes according to the schedule http://rasp,kart.edu.ua

Teaching team:

Lecturer: ***Koshevyi Serhiy Vasyliovych***, associate professor of the Department of Automation and Computer Telecontrol of Train Traffic (AT)

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Reception and consultation hours: every Thursday, 14.10 – 15.30

Location of the department (teaching): City of Kharkiv, Feuerbacha Maidan, 7, 1st building, 2nd floor, 222 auditorium.

Web pages of the course: http://do.kart.edu.ua/

Additional information materials: http://metod.kart.edu.ua

Kharkiv – 2022

1. Abstract of the academic discipline

The purpose of teaching the educational discipline «Signal auto-regulation system» (SARS) is to provide theoretical and practical knowledge of the basic principles of construction and schematic implementation on the basis of relay-contact, computer technology and modern information technologies of component systems of SAR, methods of organizing communication and exchange channels information between stationary and on-board SAR devices, the impact of the information support of SAR systems on the safety of train traffic.

The main tasks of studying the discipline of SAR are the development of theoretical knowledge and practical skills:

– the basic principles of construction, schematic implementation and functional capabilities of components of locomotive SARS: automatic locomotive signaling devices (ALS); systems of automatic brake control (SABC), automatic train guidance system (ATGS), complex locomotive safety devices (CLSD), system of forced stopping of the locomotive (SFSL), driver vigilance telemetry control system (DVTCS), etc.;

– use of digital duplex radio communication and satellite navigation systems in on-board SAR for safe control of train traffic;

– design features of SAR components, stages of the "life cycle" and stages of development, ways to achieve functional safety and reliability.

The course aims to form and develop the following master's competencies:

1. ***Scientific research, methodological***: the ability to abstract thinking, analysis and synthesis of technological processes, phenomena, mechanisms, understanding of their cause-and-effect relationships; the ability to conduct scientific research in professional activity and/or innovative activity, the ability to generate new ideas; the ability to solve problems in new and non-standard professional situations, taking into account the state and development of railway transport, social and ethical responsibility for the decisions made.

2. ***Interpersonal interaction***: the ability to work in a team, conduct scientific discussions, convince and influence other participants in group processes, demonstrate a wide range of cognitive, legal and intellectual skills for the purposes of effective functioning of train traffic control systems, protection of intellectual property; the ability to communicate and cooperate with specialists of other fields, to adapt in a social and professional environment.

3. ***Social and personal***: the ability to realize the social significance of one's profession, to be aware of the responsibility for the results of one's professional activity before the public, to apply the principles of deontology in the performance of professional duties. To have an active civic position based on democratic beliefs, humanistic and ethical values.

4. ***Instrumental skills***: mastering the skills of using modern software, Internet resources and working in computer networks, mastering the basic methods, methods and means of obtaining, storing and processing and using technical information in professional activities. Ability to oral and written business communication in national and foreign languages for communication in professional and socio-cultural spheres, information management skills, skills in working with modern technologies; the ability to apply methods and means of technical measurements, technical regulations, standards and other regulatory documents.

5. ***Ethical skills (motives)***: adaptability, sociability, creativity, tolerance, ability to system thinking and self-improvement, compliance with norms and principles of professional ethics, teaching skills; the ability to consciously replenish and expand communication skills in the professional sphere throughout life.

6. ***Forecasting skills***: the ability to identify problems, set strategic goals, forecast the development of technological and economic processes, phenomena and mechanisms.

7. ***Calculation skills***: the ability to use methods of planning, design, modeling, control, strategic analysis of technological and economic events, phenomena and mechanisms.

8. ***Deep knowledge and understanding***: the ability to develop models, analyze and structure technological and economic events and phenomena from the point of view of knowledge of modern theoretical, organizational and methodological foundations of the construction and functioning of train traffic control systems; the ability to apply mathematical and statistical methods in the collection, systematization, generalization and processing of scientific and technical information, preparation of reviews, annotations, compilation of abstracts, reports and bibliography on research objects; to participate in scientific discussions and procedures for the defense of scientific works of various levels and presentations with reports and messages on the subject of conducted research; to possess ways of spreading and popularizing professional knowledge; take an active part in scientific research and experiments, analyze, interpret and model on the basis of existing scientific concepts certain phenomena and processes in professional activity with the formulation of reasoned conclusions.

9. ***Assessment and problem-solving skills***: the ability to recognize the need and initiate changes based on the assessment of technological and economic events and phenomena, to develop algorithms for solving management problems using appropriate tools; the ability to structure and solve problems in various professional situations, the ability to apply acquired abilities, knowledge, experience and to engage in international cooperation in professional activities.

2. Why should you choose this course?

The smooth and safe movement of trains on the railway network is ensured by the technical complex of railway automation (RA), which is equipped with stations and tracks. The level of technical equipment (category) of the latter is determined by the class of railway stations. As an auxiliary or independent means of signaling, locomotive safety systems are used on mainline locomotives and motorcar trains, which provide the locomotive crew directly in the locomotive cab with information about the state of the traffic route, its permissions based on the train situation, target and current traffic parameters.

At the same time, in the conditions of increasing the weight of freight trains, the introduction of accelerated, high-speed and high-speed traffic at railway stations, the dialectical process of the development of interval regulation systems and ensuring the safety of train traffic is obvious – the role of the optical channel of passing traffic lights decreases and the role of signal information transmission channels from stationary devices and from the track to the locomotive to increase traffic safety due to the operation of on-board devices of multi-value ALS, determination of train movement parameters, its current coordinate, automatic brake control system, automatic train control, telemetric control of the driver's condition and forced train stop.

The discipline is based on the knowledge obtained during the study of fundamental, general engineering and professionally oriented disciplines, special disciplines of the profession at the first level of education.

In the lecture course, the study of the theoretical foundations of the technical means of SAR is supplemented by practical classes, the purpose of which is to familiarize with research methods and characteristics of typical methods and schematic solutions for the implementation of airborne SAR. The purpose of the practical classes is to acquire practical skills in the analysis and modeling of electromagnetic processes during the organization of the communication channel between stationary and locomotive devices of the SAR, modeling the work and performing engineering calculations of the main circuit nodes of the SAR.

The team of teachers will be ready to provide any help with the most difficult aspects of the course by e-mail and in person - during working hours.

3. Description of the academic discipline

The educational discipline "Systems of auto-signal regulation", the study of which is allocated 150 hours / 5.0 ECTS credits during the semester (1st year - 1 semester) gives master's students a deep understanding of the application of the main scientific methods of ensuring the safety of train traffic due to the expansion of the information support of SAR systems, the use in controlling the movement of trains using modern information technologies - on-board computer equipment, digital duplex train radio communication, satellite navigation.

The course consists of 30 hours of lectures, 15 hours of practical classes and 15 hours of laboratory work during one semester. It is accompanied by text material, presentations, and an individual task - calculation and graphic work (RGR). Types of control – two modular test tasks and an exam. A web resource of the course has been developed, which is placed on the Moodle platform at the link do.edu.kart.ua. Master's students will have the opportunity to apply the acquired knowledge and solve practical tasks through discussions in the classroom during laboratory work and practical classes.

Interdisciplinary connections: the discipline of SAR is based on the knowledge obtained during the study of fundamental, general engineering and professionally oriented disciplines of the Bachelor's educational and professional program (EPP): higher mathematics, physics, theory of electric and magnetic circuits, computer technology, electronics and microcircuit engineering, theory of automatic control, general theory systems, automation systems at races, station automation systems, special measurements and technical diagnostics.

The SAR discipline is the basis for the implementation of diploma design on the subject of the construction of ZA systems at races and the defense of the project in the state examination commission (SEC).

The program of the academic discipline of SARS consists of the following content modules:

Content module 1: Basics of signal autoregulation.
Content module 2: Multi-value signal autoregulation systems.
Content module 3: Modern information technologies in locomotive SARS.
Content module 4: Modern telecommunication technologies in on-board train traffic control systems.

Signal autoregulation systems / course scheme

<table>
<tr><td rowspan="11">Think about it</td><td>Lectures</td><td></td></tr>
<tr><td>Practical training</td><td></td></tr>
<tr><td>Laboratory work</td><td></td></tr>
<tr><td>Independent work for distance learning on a PC of the theoretical part of the course</td><td></td></tr>
<tr><td>Reference material</td><td></td></tr>
<tr><td>Films and presentations</td><td></td></tr>
<tr><td>Discussion in the audience</td><td rowspan="6">Execute</td></tr>
<tr><td>Group tasks</td></tr>
<tr><td>Help in the performance of a qualifying dissertation</td></tr>
<tr><td>Individual consultations</td></tr>
<tr><td>Online discussion (forum in social networks)</td></tr>
<tr><td>Exam</td></tr>
</table>

The practical lessons of the course involve the study of electromagnetic processes occurring in the communication channel between track and locomotive devices, the development of their electrical replacement circuit, and calculations of the resulting circuits. The discipline is finalized with control events (twice after the end of two educational modules - passing a test control for determining the quality of learning and an exam at the end of the semester). Completion of an individual task - calculation and graphic work (RGR) is accompanied by references to related disciplines that complement the topics and forms the master's student's innovative, informational and communicative competence.

4. Course resources

Information about the course is posted on the University's website http://do.kart.edu.ua/ (including necessary methodological materials, presentations, films, test tasks for individual content modules and course evaluation rules) in the "Distance Learning" section. The necessary preparation must be completed before the start of the lecture or practical session. During the discussion, it is proposed to carry out an analysis of the influence of information support for the effective functioning of SAR systems, ways to achieve a high level of functional safety, reliability due to the use of modern information technologies in SAR devices.

Examples of questions for discussion:

– development of an electrical calculation scheme for replacing the communication channel (inductive, radio channel) between the track and locomotive devices of the SAR;

– analysis of the electromagnetic condition within the railway track and the locomotive and its influence on the functioning of SAR devices;

– classification of sources of electromagnetic disturbances within the railway track and determination of measures to increase immunity of SAR devices;

– determination of functional safety and search for ways to increase it in locomotive devices of SAR at the following levels: hardware, software, algorithmic, informational, metrological, linguistic;

– formation of functional requirements for the components of the SAR and ways of their implementation, measures to increase the functional capabilities of the system;

– comparative analysis of the operational and technical characteristics of existing and prospective SAR systems on the railways of the European Union and post-Soviet states.

Graduate students can ask questions, as well as discuss and analyze topics of the discipline outside of lectures.

5. Distribution of lectures into content modules

Content module 1. Basics of signal autoregulation

Topic 1. General basics of locomotive signal autoregulation systems

Topic 2. Principles of construction of continuous and point systems of automatic locomotive signaling.

Topic 3. Organization of the communication channel between track and locomotive devices according to different physical principles of operation in existing domestic and foreign SAR systems.

Topic 4. Study of operating conditions and electromagnetic compatibility of on-board systems for traffic safety on railway lines of various classes and categories.

Topic 5. Analysis of sources of electromagnetic disturbances in communication channels between track and locomotive devices and their negative impact on the functioning of SAR devices.

Topic 6. Research of ways to reduce malfunctions in the operation of locomotive devices of the SAR.

Content module 2. Signal autoregulation systems on a relay and microelectronic basis

Topic 7. Automatic locomotive signaling of ALSN numerical code.

Topic 8. Unified frequency system ALS.

Topic 9. Microelectronic system of automatic locomotive signaling ALS-EN.

Topic 10. Systems of automatic brake control and automatic train driving.

Topic 11. ALS-ARS system on the subway.

Content module 3. Signal autoregulation systems based on modern information technologies and microprocessor technology

Topic 12. Peculiarities of the implementation of microprocessor technology in airborne SAR systems. Ways to achieve the conditions of functional safety of locomotive systems of SAR, built on the basis of microprocessor technology and modern information technologies.

Topic 13. Functional capabilities, construction structure, algorithm of operation of domestic locomotive safety systems of ALS-MU (ALS-MP), SLB-I.

Topic 14. Station systems of shunting automatic locomotive signaling based on microprocessor technology

Topic 15. Complex locomotive unified safety device CLUB-U. The single integrated system (ECS) of interval regulation and ensuring the safety of train traffic.

Topic 16. Locomotive systems of the SAR railways of Western Europe, North America, leading railway countries of Asia. The only European traffic safety system ERTMS – ETCS. ERTMS – GSM-R.

Topic 17. Principles of construction, technical implementation and algorithm of operation of automatic train control systems ("driver").

Content module 4. Modern telecommunication technologies and satellite navigation in locomotive train traffic control systems

Topic 18. Digital duplex radio communication in train traffic control systems based on

digital duplex CX, VHF radio communication, cellular (GSM-R) and trunking (TETRA) communication. Comparison of operational and technical indicators and functional capabilities of different types of communication for train traffic management.
Topic 19. Use of satellite navigation, electronic track map and on-board and track devices for determining train coordinates in locomotive systems for ensuring the safety of train traffic.

6. Practical classes

№ i.o.	Topic name
PC 1	General definitions in the modeling of electromagnetic processes that occur in communication channels of different physical principles of operation between track and locomotive devices of the SAR, development of their calculated electrical replacement schemes.
PC 2	Analysis of sources of electromagnetic disturbances within the railway track, research of their negative impact on the functioning of the ALS system. Study of the influence of the speed of the train on the functioning of the ALS under the condition of violation of the quasi-stationarity of the code current in the rails and the magnetic flux.
PC 3	Compilation of the calculated electrical circuit for replacing the inductive communication channel of ALSN when the train passes through the turnout zone.
PC 4	Compilation of the estimated electrical circuit for the replacement of the inductive communication channel of ALSN when the train passes through the zone of insulating joints.
PC 5	Compilation of the calculated electrical scheme for replacing the inductive communication channel of ALSN with rails left in the intertrack.
PC 6	Development of a model of an inductive communication channel between track and locomotive ALSN devices under the conditions of oscillations of receiving coils during train movement.
PC 7	Digital methods of information exchange between track and locomotive devices of ALS. Automatic locomotive signaling ALS-EN: structure, principles of coding and decoding of signal information, functionality.
PC 8	Data exchange between track and locomotive SAR devices using FSK modulation. The principle of operation of eurobalise. Basics of building the Unified European Traffic Safety System ERTMS – ETCS. ERTMS – GSM-R. Methods of determining the current coordinate of the train. Principles of construction and operation of satellite navigation systems Navstar GPS, GLONAS.

7. Laboratory work

№ i.o.	Topic name
LW 1	ALSN receiving devices. Research of the FL25/75-M locomotive filter. Construction of the frequency characteristic of the FL25/75-M filter using a personal computer.
LW 2	Study of the UK-25/50M-D locomotive amplifier.
LW 3	Analysis of FL25/75-M interference immunity and the effectiveness of the use of ARP in UK25/50M-D in case of interference of various origins in the

	inductive communication channel.
LW 4	Study of the work of the DKSV (part 1): counting group; schemes of signal relays, compliance, locomotive traffic light control.
LW 5	Study of the operation of the DKSV (part 2): schemes for controlling driver vigilance, controlling the speed of train movement, EPC, speedometer and recorder of movement parameters.
LW 6	Study of the operation of the microelectronic multi-value system ALS-EN.
LW 7	Final class, finalization and interview according to the cycle of laboratory works.

8. Independent work

№ i.o.	Topic name
1	Elaboration of lecture material based on educational literature and distance learning courses at the link http://do.kart.edu.ua (the name of the course on the UkrDUZT tab is "Signal auto-regulation systems", on the IPPC tab - "On-board control and safety systems").
2	Viewing films and presentations on distance learning courses at the link http://do.kart.edu.ua (course name on the UkrDUZT tab – "Signal autoregulation systems", on the IPPC tab - "On-board control and safety systems").
3	Preparation for practical classes
4	Preparation for laboratory work, preparation of reports on completed work.
5	Preparation and passing of tests for the content modules of the distance learning course at the link http://do.kart.edu.ua/.
6	Processing of individual sections of the program that are not taught in lectures.

9. Planned learning outcomes (OC)

The planned integral competence, general competences (GC), special (professional) competences (SC) are as follows.

1) ***Integral competence***: the ability to solve complex tasks and problems of automation and computer-integrated technologies in professional activities and/or in the learning process, which involves conducting research and/or implementing innovative activities and is characterized by the complexity and uncertainty of conditions and requirements.

2) ***General competences***:

– GC 3. Ability to abstract thinking, analysis and synthesis.

– GC 4. Ability to work in an international context.

3) Special (professional, subject) competencies:

– SC 1. The ability to automate complex technological objects and complexes, to create cyber-physical systems based on intelligent management methods and digital technologies using databases, knowledge bases, methods of artificial intelligence, robotics and intelligent mechatronic devices;

– SC 4. The ability to analyze production and technological systems and complexes as objects of automation, to determine methods and strategies for their automation and digital transformation;

– SC 5. The ability to integrate knowledge from other fields, apply a systematic approach and take into account non-technical aspects when solving engineering problems and conducting scientific research;

– SC 7. Ability to apply specialized software and digital technologies to solve complex tasks and problems of automation and computer-integrated technologies;

– SC 8. The ability to develop the functional, technical and information structure of computer-integrated management systems of organizational and technological complexes using network and information technologies, software and technical control complexes, industrial controllers, mechatronic components, robotic devices and human-machine interface tools.

4) ***Additional special competencies*** to the master's educational and scientific training program:

– SC 14. Ability to rationalize activities in the field of automation and computer-integrated control of technological processes in various fields.

Planned learning outcomes (LO):

LO 01	Create automation systems, cyber-physical production based on the use of intelligent management methods, databases and knowledge bases, digital and network technologies, robotic and intelligent mechatronic devices.
LO 02	To create highly reliable and safe automation systems with a high level of functional and information security of software and technical means.
LO 03	Apply specialized conceptual knowledge, including modern scientific achievements, as well as critical understanding of modern problems in the field of automation and computer-integrated technologies to solve complex problems of professional activity.
LO 05	To develop computer-integrated management systems for complex technological and organizational-technical objects, applying a systematic approach taking into account non-technical components of the assessment of automation objects.
LO 06	The ability to conduct scientific research on the development, analysis and research of automation systems and computer-integrated technologies individually or as part of a team, which requires a sufficient level of knowledge of methodology, processing of scientific sources, analysis of qualitative and quantitative accounting data, reporting.
LO 07	Analyze production and technical systems in a certain field of activity as objects of automation and determine the strategy of their automation and digital transformation.
LO 08	Apply modern mathematical methods, methods of automatic control theory, reliability theory and system analysis for research and creation of automation systems of complex technological and organizational-technical objects, cyber-physical productions.
LO 12	Collect the necessary information using scientific and technical literature, databases and other sources, analyze and evaluate it.

As a result of studying the academic discipline, the master's student must:

know:

– requirements of standards, normative documents and industry instructions relating to SAR systems;

– basic principles of construction, technological algorithms of functioning; technical characteristics and features of operated and promising stationary and on-board component systems for ensuring the safety of train traffic;

– basics of using microprocessor technology, modern digital train radio communication systems and satellite navigation systems in SAR systems;

– peculiarities of design of SAR systems;

– ways to achieve functional safety and reliability by SAR devices;

be able:

– rationally and correctly choose effective methods of modeling, calculation, analysis and synthesis of the main subsystems and functional units of track and on-board components of the SAR;

– maintain the operational reliability of functioning set for SAR devices;

– to ensure the necessary level of safety of train movement at the established capacity of railway stations;

– design typical systems and design individual new elements and nodes, including with the use of computer and microprocessor technology;

have an idea:

– about the trends and prospects for the development of SAR and multi-level systems of interval regulation of train movement on tracks and stations for the near and distant future;

– construction structure and technological algorithms of the functioning of domestic and foreign SARs with wide application of new information technologies and a modern element base;

– ***to find and analyze*** the necessary scientific information in the field of modeling and construction of structures for automation of control processes and ensuring the safe movement of trains;

– ***to be able to lead a discussion*** at scientific conferences and symposia and present one's own projects or qualification work as a coherent structure.

– ***to acquire*** the ability to systemically creative thinking regarding the generation of possible ideas or approaches in the process of research and modeling of the methods and structure of hardware and software for ensuring the safety of train traffic.

10. Evaluation rules

When filling out the examination report and scorebook (individual study plan) of the master's student, the grade given on a 100-point scale must be converted to the national scale (excellent – 5, good – 4, satisfactory – 3, unsatisfactory – 2) and the ECTS scale (A, B, C, D, E, FX, F).

Determination of the name according to the state scale (estimation)	Determination of the title according to the ECTS scale	On a 100-point scale	ECTS assessment
Excellent – 5	**Excellent** – excellent performance with only a few minor errors	90-100	A
Good – 4	**Very good** – above average with a few errors	82-89	B

	Good – generally correct work with a certain number of gross errors	75-81	C
Satisfactory – 3	**Satisfactory** – not bad, but with a significant number of shortcomings	69-74	D
	Sufficient – performance meets minimum criteria	60-68	E
Unsatisfactory – 2	**Unsatisfactory** – you need to work before getting credit (without re-studying the module)	35-59	FX
	Unsatisfactory – serious further work is required (re-study of the module)	<35	F

Attending lectures

Points for this component are not awarded at all, if the master's student did not attend more than 50% of the lectures in the module without valid reasons. The maximum amount is 10 points.

Practical training

They are evaluated by attending classes. The maximum amount is 10 points.

Laboratory work

They are evaluated by attendance at classes and activity in performing work. The maximum amount is 15 points.

Degree of involvement

The purpose of participating in the course is to involve you in the discussion, to expand learning opportunities for yourself and your partners, to give you another way to test your theoretical and practical knowledge of scientific research methods, to achieve the efficiency of use and safe operation of traffic safety systems, the basic principles of building their components, methods of organizing communication channels and exchanging information between stationary and on-board SAR devices, the impact of SAR information support systems on the safety of train traffic, the achievement of electromagnetic compatibility requirements by SAR devices... Participation will be evaluated based on the number and accuracy of your answers. Questions, although encouraged, are not graded in this unit. We strive to provide all students with equal and fair opportunities to increase their own engagement. The maximum amount is 10 points.

The progress of the individual task (RGR). The maximum amount is 15 points.

Final module test. The maximum amount is 40 points.

Final semester evaluation. The student receives a final grade for the semester based on current control by accumulating points. The maximum number of points that a student can get is 100 (up to 60 points of the current control and up to 40 points during the module test). If the student does not agree with the proposed points, he can increase them on the exam by answering the questions on the exam ticket.

11. Means of diagnosing the success of training

1. Oral current survey at lectures, practical classes.
2. The system of monitoring the level of knowledge by the method of testing on a personal computer while working on a course in the distance form of education.
3. Knowledge level control system by PC testing during modular control.
4. A written answer to the questions of the examination ticket on theoretical

questions and tasks on the exam (if necessary at the initiative of the master's student).

12. Code of academic integrity

Violation of the Code of Academic Integrity of the Ukrainian State University of Railway Transport (USURT) is a serious violation, even if it is unintentional. The code is available at the following link: http://kart.edu.ua/documentu-zvo-ua.

In particular, compliance with the Code of Academic Integrity of USURT means that all work on exams and tests must be done individually. During independent work, students can consult with teachers and other students, but must solve tasks independently, guided by their own knowledge, abilities and skills. References to all resources and sources (for example, in reports, independent papers or presentations) should be clearly identified and properly formatted. In the case of joint work with other students on individual tasks, you should indicate the degree of their involvement in the work.

13. Integration of students with disabilities

Higher education is a leading factor in raising social status, achieving spiritual and material independence and socialization of youth with limited functional capabilities and reflects the state of development of democratic processes and humanization of society.

To integrate students with disabilities into the educational process of the USURT, a distance learning system was created based on modern pedagogical, information, and telecommunication technologies. Access to distance learning materials from this course can be found at the following link: http://do.kart.edu.ua/ (the name of the course on the USURT tab is "Signal autoregulation systems", on the IPPC tab - "On-board control and safety systems") .

Recommended Books

The main one

1. Boynyk A.B. Systems of interval regulation of train movement on races: [Text] / A.B. Boynyk, S.V. Koshevoy, S.V. Panchenko, V.A. Centurion - Study guide. Kharkiv: UkrGAZHT 2005. – 256 p.
2. Vynogradova V.Yu. etc. Peregonnye systems of automation. - M.: Route, 2005.-235 p.
3. Kazakov A.A. Automated systems of interval regulation of train traffic: [Text] / A.A. Kazakov, V.D. Bubnov, E.A. Kazakov - M.: Transport, 1995.-320 p.
4. Kravtsov Yu.A. Systems of railway automation: [Text] Yu.A. Kravtsov, V.L. Nesterov, G.F. Lekuta - M.: Transport, 1996. - 400 p.
5. Leonov A.A. Maintenance of automatic locomotive signaling. - M.: Transport. 1982.-254 p.
6. Lysenkov V.M. Statistical theory of train movement safety. - M.: VYNITY RAS, 1999.-332p.
7. Lysenkov V.M. Theory of automatic interval regulation systems. - M.: Transport, 1987.-150 p.
8. Makhmutov K.M. Devices for the interval regulation of the movement of trains on the subway. - M.: Transport, 1986. - 351 p.
9. Kotlyarenko N.F. Road blocking and autoregulation: [Text] / N.F. Kotlyarenko, A.V. Shishlyakov, Yu.V. Sobolev, I.Z. Skrypin - M.: Transport, 1983. - 408 p.
10. Astrakhan V.I. Unified locomotive safety device (CLUB-U): Study guide: [Text] / V.I. Astrakhan, V.I. Zorin, G.K. Kiselhof and others Ed. YOU. Zoryna and V.I.

Astrakhan. - M.: GOU "Educational and Methodological Center for Railway Transport Education". 2008. – 177 p.

Additional

1. Rules for the technical operation of railways of Ukraine, approved by the order of the MTU dated December 20, 1996 No. 411, with changes and additions made by the orders of the MTU dated June 8, 1998 No. 226, July 23, 1999 No. 386, dated March 19, 2002 No. 179.
2. Instruction on signaling on railways of Ukraine. TSH 0001, Kyiv: Ministry of Transport of Ukraine, 2008.
3. Instruction on the movement of trains and shunting work on the railways of Ukraine. CD 0001, Kyiv: Ministry of Transport of Ukraine, 1995.
4. Periodic scientific and technical literature.

Information resources

1 NTB USURT (Kharkiv, Feuerbacha Square, 7).
2 Media library of USURT (Kharkiv, Feuerbacha Square, 7).
3 KhDNB named after V.G. Korolenko (Kharkiv, Korolenko Ave. 18).
4 Kharkiv Central Technical University (Kharkiv, 4 Gagarina Ave.).
5 Information resources on the Internet

1. http://metod.kart.edu.ua/
2. http://do.kart.edu.ua/
3. http://kart.edu.ua/documentu-zvo-ua