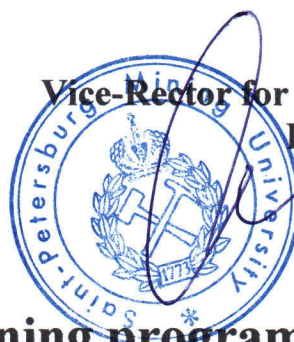THE FIRST HIGHER TECHNICAL UNIVERSITY IN RUSSIA

MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
Federal State Budgetary Educational Institution of Higher Education
"Saint-Petersburg Mining University"

IOM3
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APPROVED

I⊑m³
The Institute of Materials,
Minerals and Mining

Approved by
Vice-Rector for Educational Activity
Prof. V.A. SHPENST

21/02/2017

Professional training program
«Modern systems of automation and control of technological processes in petroleum refining»

Professional standard:
Specialist in automated systems of production management;
Specialist in automation and mechanization of production processes (in development);
Specialist in automated control systems of technological processes in oil refining (in development)

Training areas:
15.03.04 - *Automation of technological processes and production;* **21.03.01** — *Oil and gas*

Priority for the modernization and technological development of the Russian economy: Information and telecommunication systems.

Critical technologies of the Russian Federation: Technologies of information management, navigation systems, energy-efficient technologies of production and conversion of energy into fossil

Form of study: full-time

Course leader:

Developers:

Head of Department of Technological
Process Automation and Production
Prof. V.Yu. Bazhin

Associate prof. A.Yu. Firsov
Associate prof. N. I. Koteleva
Associate prof. A.A. Kulchitsky
Associate prof. P.A. Petrov
Associate prof. P.V. Ivanov
Associate prof. N.A. Romanova
Assistant   D.V. Gorlenkov

ST. PETERSBURG
2017

1. General provisions

1.1. The goal of the training course:

Improving the training of managers and engineering and technical services specialists in automation, control and dispatching, by improving and acquiring new theoretical and practical knowledge in research, development and operation of means and systems of automation and management for various purposes, including the lifecycle of the product and its quality with regard to specific conditions of oil refineries on the basis of domestic and international regulations. The training courses is drawn up in accordance with professional standards "Specialist in automated systems of production management", "Specialist in automation and mechanization of production processes", "Specialist in automated control systems of technological processes in oil refining".

1.2. Competences to be formed

The key professional competences to be formed are presented in the table below:

No. competence	Target groups	Description of competence / readiness to perform labor action in the context of professional activities
1	Engineer of automation and mechanization of production processes, the Specialist in automated systems of	The ability and experiences to participate in the development and practical development of the means of production control systems of the product, its lifecycle and quality, development of new technology, in the generalization and systematization of results;
2	production management Specialist in automated control systems of technological processes in oil refining	The ability to perform works on commissioning, setting up, adjusting, experimental verification, technical maintenance, maintenance of equipment, means and systems automation, control, diagnostics, testing and management software tools;
3		The ability to choose methods and means of measuring the performance of the equipment, means and systems automation, control, diagnostics, testing and management, configuration and maintenance: system, tool and application software data tools and systems;
4		The ability to participate in the organization of diagnostics of technological processes, equipment, facilities and systems of automation and management;
5		The ability to participate in the organization of acceptance and development of commissioned equipment, technical means and systems automation, control, diagnostics, testing and management;
6		The ability and experiences to develop practical measures to improve systems and automation and production control of the product, its lifecycle and quality and to improve the quality of products, technical support of its production, the practical implementation of measures in the workplace; to conduct production monitoring their implementation;

No. competence	Target groups	Description of competence / readiness to perform labor action in the context of professional activities
7		The ability and experiences to participate in the implementation and updating of technological processes, means and systems of automation, control, monitoring, diagnostics in the preparation of new products and assessment of its competitiveness;
8		The ability and experiences to participate in the development of new automated and automated technologies products and their implementation, evaluation of results, preparation of technical documentation for automation of production means and equipment;
9		The ability to use modern information technologies of management and control of technological processes of oil and gas;
10		The ability to provide the necessary flexible means and systems of automation, control, diagnostics and management under the effect of external factors that reduce the effectiveness of their operation and planning for continuing improvement of automation systems;
11		Willingness to explore scientific and technical information, domestic and foreign experience in the development, implementation and operation of automated control systems.

1.3. Requirements for academic performance.

In order to achieve the professional competencies presented in Tabel 1.2, the student must:

Study practical experience in:
- the creation and development of a unified integration platform of the enterprise;
- the use of computer-technology and software modeling of objects and processes of oil and gas processing;
- using capabilities of software tools Aspen HYSYS and Aspen Plus in modeling chemical technological processes and schemes;
- the work with modern instrumentation that is used at enterprises of oil and gas;
- maintenance and operation of modern programmable logic controllers, including controllers, telemetry;
- maintenance and operation of modern SCADA-systems used at enterprises of oil and gas;
- creating, configurating, troubleshooting and protection channels to transmit data on oil and gas industrial enterprises.

Get skills:
- in the field of modern automated control systems of technological processes of objects of gas distribution networks;
- to choose the best modes of carrying out the refining processes and use of physico- chemical principles for process control;
- to determine the optimal technological parameters for the monitoring of oil refining processes;
- to apply modern software tools to calculate the characteristics of individual organic compounds and their mixtures; use the data for the calculation of chemical-technological processes;
- to use application software packages for calculating equipment parameters and selection of technological schemes;
- to possess principles for the rational management of technological processes in the professional field;

- to properly choose the mathematical models of technological objects from the library and create, if necessary, non-standard models of technological objects;
- to apply mathematical methods for modeling of technological schemes;
- to create a scheme of control of technological objects and systems taking into consideration the mutual influence of the devices and conditions of their functioning on the statics and dynamics of the scheme;
- to apply the main provisions of the methods of analysis and synthesis of complex technological schemes in conjunction with automatic control systems;
- to use modern technical means of automation of oil refineries;
- to use modern software and hardware systems of automated control of technological objects of oil and gas;
- to use modern methods of protection of technological information.

Get knowledge:
- of the concept of development of automated control systems at the enterprises of oil and gas;
- of new directions in the theory and practice of automation objects and processes in the oil refining industry;
- about the basic properties of technological raining processes as control objects;
- about the methods of creation and analysis of models permitting to predict the properties and behavior of objects of oil and gas;
- of the methods of synthesis of technological schemes in specialized software packages using for example the software package Aspen Plus;
- about the methods of job compositions and properties of the material and energy flows of technological schemes and, if necessary, their modification;
- about jobs, conditions of functioning of technological schemes and calculation methods providing determination of optimal conditions using optimization criteria and mathematical optimization methods;
- about the main characteristics and features of instrumentation used at the enterprises of oil and gas;
- about wired and wireless data transmission technologies;
- about the main technical characteristics, peculiarities of implementation, configuration, and operation of modem programmable logic controllers and SCADA-systems;
- of modern systems of telemetering and tele-mechanics;
- about information security and how to ensure.

1.4. Course description

Type of academic work	Total hours
Total program	144
Lectures	74
Laboratory and practical classes	66
Testing	4

1.5. Course structure

N0.	Module title	Total hours	Including		The list of competencies o be formed, according to the list in 1.2
			Lectures	Practical (laboratory classes)	
1.	Module 1. General organization of automated control systems of technological processes of oil refining.	22	18	4	1,6, 8,11
2.	Module 2. Features of automation of technological processes of oil refining	32	16	16	4, 6-8, 11
3.	Module 3. Computer simulation of the apparatus and typical processes of oil and gas processing	30	14	16	4, 6,9
4.	Module 4. Technical means of automation of oil refineries	20	12	8	1-5,10,11
5.	Module 5. Modern software tools for automated control systems of technological processes of oil refining.	18	8	10	1-3,9,11
6.	Module 6. Operation of automated control systems of technological processes at the enterprises of oil refining industry	18	6	12	2,5,10,11

1.6. Form of final examination

The form of final examination is testing.

1.7. Documents confirming professional development of students

After training program has been successfully accomplished, students obtain standard certificates of professional development.

1.8. Academic staff involved in the program

No.	Full name	Education (University, year of graduation, specialty)	Position, academic degree, the title. Work experience in this or a similar area, years	List of main scientific and educational publications
Course leader				
1.	Bazhin Vladimir Yurievich	Ural State Technical University UP I, 1985, metallurgy of non-ferrous metals	Professor, Doctor of Technical Sciences, Dean of chemical and metallurgical faculty, a member-correspondent. Academy of natural Sciences, specialist in the field of electrolytic production of aluminum and alloys and products on its basis, 30 years	The author of over 200 scientific publications, including 16 patents
Lecturers				
2.	Sharikov Yuri Vasilevich	Institute of technology, Lensoviet, 1958	Professor, Doctor of technical Sciences, specialist in the field of processes and devices, more than 50 years.	The author of over 150 scientific papers.
3.	Ivanov Pavel Vladimirovich	Saint Petersburg state mining Institute named after G. V. Plekhanov (technical University), 2005	Associate Professor, candidate of technical Sciences, specialist in the field of hydraulic calculations, 8 years.	The author of over 20 scientific papers.
4.	Koteleva Natalia Ivanovna	Saint Petersburg state mining Institute named after G. V. Plekhanov (technical University), 2007, "automation of technological processes and productions"	Associate Professor, DEP. automation of technological processes and production, Ph. D,, 6 years.	The author of more than 25 scientific works, including 1 patent for invention.
5.	Kulchitsky Aleksandr Aleksandrovich	Marine technical University, 1995	Associate Professor, candidate of technical Sciences, specialist in the field of automated systems of control of technological parameters, 15 years.	The author of over 50 scientific papers.

No.	Full name	Education (University, year of graduation, specialty)	Position, academic degree, the title. Work experience in this or a similar area years	List of main scientific and educational publications
6.	Petrov Pavel Andreevich	Saint Petersburg state mining Institute named after G. V. Plekhanov (technical University), 2006	Associate Professor, candidate of technical Sciences, specialist in the field of automated control systems process of electrolytic production of aluminum and simulation of refining processes, 7 years.	The author of over 30 scientific papers.
7.	Romanova Nataliya Aleksandrovna	Ufa state oil technical University, 2006	Associate Professor, candidate of technical Sciences, specialist in the field of processes and devices, 7 years.	The author of over 20 scientific works.
8.	Boikov Aleksei Viktorovich	National mineral resources University "Mining", 2012	Assistant Professor, candidate of technical Sciences, specialist in the field of information-measuring systems, 3 years.	The author more than 10 scientific papers.
9.	Smirnov Andrei Gennadevich	North-West technical University (SZTU), 2010 Information system in production and business.	Head of the laboratory of the Department of automation of technological processes and production, 5 years.	The author more than 10 scientific papers.
10.	Gurko Valery Ivanovich	The Kuzbass Polytechnic Institute, 1970	Senior lecturer, specialist in the installation and repair of heating engineering devices and equipments of oil refining, the specialist for 45 years.	

1.9. Course program

The content of the training program

Section title	Content of the training material, laboratory works and practical classes, independent work of students	Hours
Module 1. General organization of automated control systems of technological processes of oil and gas processing		
Theme 1. Topical issues of automation of enterprises of oil and gas processing	The general concept of development of automation systems for oil and gas processing.	2
	Practical lesson: Round table "problems of implementation and operation of automated control systems of technological processes of oil refining".	2
Theme 2. Normative documentation in the field of automation of technological processes and productions	International, national and industry standards for the development, implementation and operation of automated control systems of technological processes of oil refining.	2
Theme 3. Principles of integration of automation systems	Place of automated control systems in the hierarchical structure of automated systems of industrial enterprises. MES, ERP, LIMS, DCS - system. Integration of automation systems in an industrial plant.	2
	Practical lesson: "Integration of automation systems".	2
Theme 4. Technical requirements for automated control systems of technological processes of oil refining and the means of achieving them	Basic technical requirements and the means of achieving them to the structure of the control system, power supply, communication equipment and means of data transmission, reliability, software, informational and mathematical, metrological assurance, performance characteristics, standardization and unification.	4
Theme 5. Functional requirements for automated control systems of technological processes of oil refining and the means of achieving them	Basic functional requirements and ways of their achievement to the volume of monitored parameters for implementation of control algorithms, to interact with related systems, to the organization of remote control, to arrange the transfer of technological information and data, to functional redundancy.	2
Topic 6. World experience of automation facilities for oil and gas processing	World experience of development, design, implementation and operation of automation systems of technological objects of oil and gas processing industries.	2
Theme 7. Life cycle assessment of process control system	Life cycle of DCS. Medco life cycle assessment. Ways of improving the reliability of process control and increase the life cycle. The questions assess the economic efficiency of introduction of automated control systems of technological processes and production of industrial enterprises.	4

Section title	Content of the training material, laboratory works and practical classes, individual work of students	Hours
Module 2. Features of automation of technological processes of oil and gas processing		
Theme 1. Automation of standard technological processes	Features of construction and calculation of control systems flow, level, temperature, automation of technological processes of mixing, heat, mass transfer. Features of automation of continuous and batch processes.	4
	Practical lesson: "Building loop temperature control in the apparatus of continuous action".	4
Theme 2 automation of processes of primary processing of oil	Automation of the processes of dehydration and desalting of oil installations ELOU. Automation of processes of oil refining at facilities at and ED.	4
	Practical lesson: "Automation of process of rectification in plate columns".	4
Theme 3. Automation of the processes of catalytic processing of gasoline fractions	Automation of the isomerization process, automation of the process of catalytic reforming, automation of the process of catalytic reforming with continuous catalyst regeneration. Automation of the process of catalytic cracking. Automation of the processes of hydrogenation of unsaturated hydrocarbons.	2
	Practical lesson: "Secondary distillation of gasoline in the system of two Packed columns with a regular nozzle".	2
	Practical lesson: "Research of process of reforming of straight-run gasoline in a pilot plant with a cascade of three reactors".	2
	Practical lesson: "Investigation of heat recovery in the node of the reformer".	2
	Practical lesson: "Study of the stabilization process of reforming products in the stabilizing column of the node reformer".	2
Theme 4. Automating the process of hydroforming petroleum fractions and thermal processes of oil refining	Process automation of Hydrotreating of motor fuels. Automating the process of hydro cracking. Automation hydrothermal processes. Automation of the process of delayed coking. Automation of process of thermal cracking. Automating the process of visbreaking. Automation of the pyrolysis process.	4
Topic 5. Automation of processes for producing hydrogen, sulfur, and blending of motor fuels	Scheme of automation of the process of producing hydrogen. Scheme of automation of the process of obtaining sulfur. Automation of the processes of compounding motor fuels.	2

Section title	Content of the training material, laboratory works and practical classes, individual work of students	Hours
Module 3. Computer simulation of the apparatus and typical processes of oil and gas processing		
Topic 1. General issues of computer modeling of chemico-technological processes	Current issues modeling of chemical-technological processes. The functionality of the modeling software. The processes of chemical technologies available for simulation software packages.	4
Topic 2. The use of information-modeling software for the design of technological schemes	Basic packages of simulation programs for the design of technological schemes of MATLAB, Aspen Plus, HYSYS. Ways of specifying devices and the connection diagrams of machines in information-modeling programs. The job flow information and the technological scheme. The choice of methods for calculating the physico-chemical properties of the components. The inclusion of modules of elements of chemical-technological schemes in information-modeling program.	4
	Practical lesson: "The basic Foundation of Aspen Plus. The creation of the technological scheme and startup of process modeling".	2
	Practical lesson: "The basics of working in the system HYSYS".	2
	Practical lesson: "Enter the schema in Aspen Dynamics and the modification of the generated loops".	2
Topic 3. The analysis of existing chemical and technological industries with the help of information-modeling programs	The design of optimal schemes with information- modeling programs.	2
	Practical lesson: "Evaluation of dynamic properties of process of gas dehydration using trietilenglikol in the system HYSYS".	4
Theme 4. The solution of optimization problems in petroleum refining using application programs	Criteria of optimization methods for solving optimal problems in dynamic systems using computer simulation.	4
	Practical lesson: "Economic optimization of the process debutanization".	2
Topic 5. The use of static and dynamic models in systems of automation of technological processes of oil refining	Practical lesson: "Synthesis of the control system of the rectification process using static and dynamic models Aspen Dynamics".	4

Section title	Content of the training material, laboratory works and practical classes, individual work of students	Hours
Module 4. Technical means of automation of oil refineries		
Topic 1. Control and measuring devices and the equipment for equipment of objects of gas distribution networks	Comparison of the main technical characteristics, reliability, faultless performance and price characteristics of instrumentation and equipment for facilities of the oil refining industry. Features of operation, configuration and calibration of sensor equipment.	2
	Practical lesson: "Assessment of the reliability of sensor equipment."	4
Topic 2. Metrological support of measurement tools	International Metrology activities. Ensuring the uniformity of measurements. The concept of measurement uncertainty. Metrological assurance measurements.	4
Topic 3. Programmable logic controllers	The main technical characteristics, peculiarities of implementation, configuration, and operation of modern programmable logic controllers. The range of programmable logic controllers used in refining facilities. Use the PLC in high-consequence facilities.	2
Theme 4. Organization of data transfer in automated systems of control of technological processes of oil refining	The concept of computer networks; types and network topologies; communication channels in computer networks; characteristics of communication channels; wireless data transmission technology and their characteristics; the concept of network protocols; the OSI model; IPv4 and IPv6; physical (MAC) and logical (IP) address; classful and classless addressing; DHCP; the concept of routing; TCP and UDP; the concept of ports; network address translation (NAT).	4
	Practical lesson: "Design, modeling wireless networks. Troubleshooting in wireless networks".	4
Module 5. Modern software tools for automated control systems of technological processes of objects of the oil refining industry		

Section title	Content of the training material, laboratory works and practical classes, individual work of students	Hours
Topic 1: Programming industrial controllers	Programming languages of IEC - a language of diagrams of functional blocks FBD language LD ladder logic, language, sequential function chart SFC, structured text ST, instruction list IL. Using basic elements from libraries of functional blocks EFB. The modes of operation of PLCs; features of development of application programs PLC, General type and special function blocks PLC The separation of access rights to the PLC. Order "cold" and "warm" restart. Forcing of inputs/outputs and internal variables. Diagnostics of the controller operation: CPU, modules, I/o, specialty modules. Use for diagnostics of operator screens.	4
	Practical lesson: "Using standard programming languages of the IEC programming industrial controllers".	4
Topic 2. Basis for the use of SCADA systems for control of technological processes of oil refining facilities	Structure, basic functions, principles, setup, programming and operation of modern SCADA- systems.	2
	Practical lesson: "Basics of SCADA programming-systems".	4
Topic 3. Basis for the use of OPC-servers in the structure of the automated control systems of objects of oil refining	The theoretical basis for the use of OPC-servers in the structure of the automated control systems of technological objects of oil-refining industry. The standards of the ODP.	2
	Practical lesson: "Configuration and setup of the OPC-server for solving problems of automation of technological processes of oil refining".	2
Module 6. Operation of automated control systems of technological processes at the enterprises of oil refining industry		
Topic 1. Network fundamentals	Organization and commissioning of process control systems. Organization of repair and maintenance of process control systems. Requirements for personnel conducting maintenance control system. Safety requirements for operation and maintenance of process control systems. The output of control systems, from service. Requirements for operational documentation, spare parts devices and equipment for process control systems, their transportation and storage. Information security control system.	4
	Practical lesson: "Diagnostics of the safety and reliability of control systems".	2
	Practical lesson: "Calculation of the number of personnel control systems".	4

Section title	Content of the training material, laboratory works and practical classes, individual work of students	Hours
Topic 2. Information security of control system.	The concept of network security; types and classification of threats; methods to ensure network security (authentication, authorization and audit); the prevention, detection and protection against network attacks; firewalls; the concept of cryptography (symmetric encryption system and public key); * organization of secure communications channels (SSH, VPN); authentication and encryption of information in wireless networks (WEP, WPA, WPA2, A3, A5, A8).	2
	Practical lesson: "Ensuring the security of your wireless networks".	4
	Practical lesson: "Modeling and detecting vulnerabilities in wireless security".	2

1.10. Test questions

1. List the main features of the DCS, MES and ERP systems used at industrial enterprises of the oil refining industry.

2. What are the main approaches to the integration of automation systems in an industrial plant.

3. What methods of evaluation of the life cycle of process control systems do you know? Which of them is most preferable to apply to the assessment of the life cycle of process control systems petroleum industry?

4. List the main international organization that develops standards for APCS.

5. What are the main technical requirements for automated control systems of technological processes of oil refining.

6. Form the functional scheme of automation of standard technological processes.

7. List the features of automation of processes of primary processing of oil.

8. List the features of automation of processes of catalytic processing of gasoline fractions.

9. List features of automation of the process of hydroforming petroleum fractions.

10. List the features of automation of processes of obtaining hydrogen, sulfur, and blending of motor fuels.

11. List the main features of static and dynamic models used in systems of automation of technological processes of oil refining.

12. Describe an algorithm for constructing models of machines and typical oil refining processes.

13. List the main types of software for simulation of refining processes, their characteristics, advantages and disadvantages.

14. Describe the algorithm of synthesis of control systems using models.

15. List the task list automatic control, solve by using software and modeling systems.

16. Describe the stages in the development of computer modeling of chemico- technological processes.

17. What are the characteristics of static and dynamic simulation of oil and gas?

18. List the main features of the system, Aspen Plus in the simulation of technological schemes.

19. The purpose of the software package HYSYS.

20. Please provide a brief description of methods for calculating thermodynamic properties based on equations of state.

21. Describe the calculation of thermodynamic properties by the methods of the activity coefficients of the liquid?

22.　Describe General sequence of actions during create process models in a specialized software package.

23.　List the main features of sensor equipment used at the facilities of oil refining,

24.　List the basic principles of ensuring the uniformity of measurements.

25.　List the main features of a PLC used in industrial dangerous objects.

26.　List the principles of information exchange in PCs.

27.　Specify the basic protocols used to communicate elements of process control systems in refining industry.

28.　Enter the main programming languages of the controllers according to the IEC standard. List the basic elements of the language LD,

29.　List the basic configuration of SCADA systems.

30.　List the main functions of SCADA systems.

31.　List the standards of the ODP. Specify a brief description, advantages and disadvantages from the point of view of use in process control systems of oil refining.

32.　List the list of works upon the reception of control systems in operation.

33.　List the requirements for personnel conducting maintenance control system.

34.　List the basic safety requirements in the operation and maintenance of process control systems.

35.　List of work when the industrial control systems out of service.

36.　List the methods and means of ensuring information security in process control systems.

1.11. Material and technical conditions for the program implementation

For the implementation of the programme the auditoria of the Center of Continuing Professional Education are equipped with multimedia equipment, laboratory automation hardware; automation of continuous technological processes with plants "plate distillation column", "Packed distillation column", simulator-simulator setup "plate distillation column"; information measuring systems; dedicated lab computers that have specific software SQL Server Fix Dynamics SCADA, Schneider Electric Citect SCADA, Schneider Electric Unity Pro Schneider Electric Unity Application Generator, Trouble Shooter GE and GE Cause; interfaculty laboratory of process control and showrooms of the manufacturers of modern automation systems located in St. Petersburg,

Specialized software packages HYSYS, Aspen Plus, ReactOp.

1.12. Information support of the program.

List of recommended textbooks, Internet resources, secondary literature:

Main sources:

1. Anashkin A. S. instrumentation and software for distributed control systems./ Kadyrov E. D. the Khazars V. G./ed. by V. Husarova G St. Petersburg, 2004, 366 p.

2. Benkovich E. C. Practical modeling of complex dynamic systems. / Benkovich E. S., Y. B. Kolesov, Y. B. Senichenkov. - SPb.: BHV, 2001. - 441c.

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4. Blagoveshchenskaya M. M. Information technology systems of control of technological processes. Proc. for higher education institutions. / M. M. Blagoveshchenskaya, L. A. Zlobin, M., Vyssh. Sch., 2005. - 768 p

5. Hartmann T. N. Computer simulation of chemical processes: studies manual for high schools / T. N. Hartmann, D. V. Klushin. - M.: ICC "Akademkniga", 2006. - 416 p.

6. Golovizina M. Automated technological complex. LAP Lambert Academic Publishing, 2015.-320 p.

7. Gokhberg, G. S., Sofievskiy A. V. and Korotkin, A. A. Information technology, M.: Academy, 2012-208.

8. Dorf, R. Modern control systems / R. Dorf, R. Bishop. TRANS, angl. B. I. Kopylova. - M.: Laboratory Of Basic Knowledge, 2002. - 832 p.

9. Ermolenko, D. A. automation of processes of oil refining: a manual / D. A. Ermolenko, O. N. Kashin, N. In. Lisitsyn; Under the General editorship of V. G. Kharazov. - SPb.: Profession, 2012. - 304 c.

10.　Kelim　Y. M. Typical elements of automatic control systems. Training manual. Moscow: Forum-infra-M, 2002, 383 p

11. Panichev, V. V. Computer simulation: a tutorial / V. V., Panichev, N. And. Soloviev - Orenburg: OSU GOU, 2008. - 130 p.

12. Pakhomov A. N. Fundamentals of modeling of chemical-technological systems: textbook / A. N. Pakhomov, V. I. Konovalov, N. C, Gatapova, A. N. Koliukh. - Tambov: Publishing house of compromise, state technical. University, 2008.-80.

13. Sotskova E. L., Golovlyov and S. M. Fundamentals of automation of technological processes of oil refining and gas. Textbook, Moscow: Academia, 2014-304 PP.

14. Kharazov V. G. Integrated system of control of technological processes - SPb.: Profession, 2014.-592 p.

15. Sharikov Y. V., Beloglazov I. N. The reactor equipment in the process of oil and gas processing, Mining University, Saint-Petersburg, 2012.

16. Shishmarev V. Y. the automation of technological processes, Moscow: Academia, 2014.-368 p
Additional sources:

1. Automatic control in the chemical industry: a Textbook for high schools. Edited by E. G. Dudnikova. - M.: Chemistry, 1987. - 368 p

2. Adelson, S. V., Vishnyakova, Puskin J. M., Technology of petrochemical synthesis. M., Chemistry, 1985

3. D. Park, S. McKay data systems monitoring and control, M.: the IDT Group, 2007 - 480 p.

4. Demenkov N. P. Software tools optimize the settings of control systems: Proc. allowance. - M.: Izd-vo MGTU im. N. Uh. Bauman, 2006.-244 p.

5. Demenkov N. P. Languages for programming industrial controllers: a textbook - M.: Publishing house MGGA them. N. Uh. Bauman, 2004. - 172 p.

6. Kadyrov E. D., Kravchenko, A. N., Firsov Y. A. Programmable logic controllers. Programming and configuring. Tutorial/ St. Petersburg, ed. Spggi (TU), 2007, -119с.

7. Cracking oil fractions over zeolite catalysts, edited by S. N. Hadjiev, M., Chemistry, 1982

8. Kuznetsov A. A., Kagermanov S. M., Sudakov, E. N. Calculations of processes and apparatuses of the oil refining industry. "Chemistry", L. 1974.

9. Magaril, R. Z. Theoretical fundamentals of chemical processes of oil refining., L., Chemistry, 1985

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12. Рак N. And. Computer modeling in examples and problems / N. And, Рак. - Krasnoyarsk, 1994. - 120 p.

13. Industrial catalytic reforming unit. Edited by H. A. L. Lastovkina Chemistry, 1984

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15. Guide the oil refiner, edited by G. A. Lastovkin, E. D. Radchenko, M. G. Rudin. L., Chemistry, 1986.

16. Fedorov Yu. N. Fundamentals of building control systems in hazardous industries. In 2 volumes. Vol. 1. "Methodology". -M.: SINTEG, 2006.

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18. Shannon R. Imitating modeling of systems. Art and science / Shannon R. - M.: Mir, 1978.-418.

Internet resources:
1. Schneider Electric http://www.schneider-electric.com/site/home/index.cfm/ru/
2. National Instruments, http://www.ni.com
3. Math Works, http://www.mathworks.com
4. Cisco, http://www.cisco.com
5. AspenTech, http://www.aspentech.com

1.13. Electronic version of educational and training sets

The content of electronic versions of teaching materials of the program:

- the training program, in electronic format;
- demo presentation reflecting the structure and content of the lecture material in electronic format;
- handouts used during lectures, laboratory and practical works, in electronic format;
- a list of indicative themes of qualification papers in the program, in electronic format;
- guidelines for students in performance of laboratory and practical works.