Ministry of Science and Higher Education of the Russian Federation

Federal State Budgetary Educational Institution of Higher Education
Perm National Research Polytechnic University

APPROVED BY
Pro-rector for Academic Affairs
_____ N.V. Lobov
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ACADEMIC COURSE WORKING PROGRAM

Academic course: Automation of process controls in oil and gas production
(Name)

Form of education: Full-time
(Full-time /full-time – correspondence/correspondence)

Level of higher education: Bachelor's program
(Bachelor's program/specialist program/
Master's program)

Workload in hours (in credits): 144 (4)
(Hours (CU))

Training program (degree): 21.03.01 Oil and Gas Engineering
(Code and denomination of degree)

Direction: Oil and Gas Engineering
(Title of curriculum)

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1. GENERAL PROVISIONS

1.1. GOALS AND OBJECTIVES OF THE COURSE

The goals of the course:

- to master the techniques and methods of constructing automatic control systems for technological processes at oil and gas facilities
- to form the working skills for technological automated equipment

Objectives of the Course:

- To study the devices and the functioning principle of microprocessor technology
- To form the skills for the development of block diagrams programs for the controller to monitor technical means and actuators of automatic control systems for industrial and technological processes
- To form the skills for automatic control of production process systems

1.2. STUDIED OBJECTS OF THE COURSE

- Information receiving devices (sensors) and executive devices
- Automation systems elements
- Microprocessor technology
- Methods of automatic and automated control

1.3. STARTING CONDITIONS

Unstipulated

2. PLANNED RESULTS OF THE COURSE TRAINING

Compe-tence	Indicator's Index	Planned Results of the Course Training (to know, to know how, to master)	Indicator of Attaining Competence which the planned results of training are correlated with	Means of Assessment
1	2	3	4	5
PC-1.4.	**IA-1**$_{pc-1.4.}$	**To know** the operating principle of sensors and actuators; algorithms for industrial processes control and their implementation programs; the operation principle of automatic control systems for industrial processes in the development and operation of oil and gas fields	**Knows** technological processes in the field of O&G engineering for the organization of the employees' work.	Grading test
PC-1.4.	**IA-2**$_{pc-1.4.}$	**To be able to** adjust sensors and actuators depending on the specified conditions;	**Is able to** make performing decisions in case of convergence of opinion and	Reports on laboratory work

1	2	3	4	5
		create programs (block diagrams) to monitor the controller; create programs (flowcharts) for industrial processes control in the development and operation of oil and gas fields	conflict of interests, determine work procedure.	
PC-1.4.	**IA-3$_{pc-1.4.}$**	**To master the skills of** using sensors and actuators applied in the oil and gas industry, creation programs (block diagrams) to monitor the controller; creating programs (flowcharts) to monitor the controller; creating programs (flowcharts) for industrial processes control in the development and operation of oil and gas fields	**Masters the skill of** operational maintenance of technological processes in the field of O&G engineering.	Reports on laboratory work

3. FULL TIME AND FORMS OF ACADEMIC WORK

Form of academic work	**Hours in all**	**Distribution in hours according to semesters**
		Number of semester
		7
1. Holdingclasses (including results monitoring) intheform: 1.1.Contactclasswork, including:	54	54
– lectures (L)	34	34
– laboratory work (LW)	18	18
– practice, seminars and/other seminar –typework (PW)		
– control of self-work (CSW)	2	2
– test		
1.2. Students' self-work (SSW)	90	90
2. Intermediate attestation		
Exam	9	9
Grading test		
Test (Credit)		
Course Project (CP)		
Course Work (CW)		
Total workload in hours	**144**	**144**

4. COURSE OUTLINE

Name of the units with the course outline	Full time of classroom activity in hours according to the forms			Full time of extracurricular work in hours according to the forms
	L	LW	PW	SSW
1	2	3	4	5
Semester 7				
Introduction Automation goals and objectives of oil and gas industrial processes	2	0	0	2
Module 1. Elements and structures of technological process automation systems. Section 1. Control and its types. Topic 1. Manual control. Automatic control: automatic control devices operating based on the compensation of the control result deviation from the set value; control devices operating on the principle of external influences compensation on the control object. Automated control. Topic 2. Information and its role in control. Information display forms. Technical means of obtaining information. Topic 3. Classification of automatic control systems. Classification of automatic control systems for performing control tasks. Classification of automatic control systems by purpose. Classification of automatic control systems according to the principle of operation. Topic 4. Technical means of obtaining information. Methods and means of automatic control for technological processes. Technical means of APCS. Description and operating principle of linear and angular displacement, pressure, temperature, force-torque, speed, level and flow sensors, fiber-optic and smart sensors. Topic 5. Executive devices and mechanisms. Electric actuators. Elements of industrial pneumatic automation. Hydraulic actuators. Section 2. Microprocessor technology. Topic 6. Basics of microprocessor technology. Logic functions and logic circuits. Triggers. Serial and parallel registers. Impulse counters. Scramblers and decoders. Multiplexers. Distributors. Adders. Microprocessors in the oil and gas industry. Topic 7. Signal converters. Architecture and principle of operation of analog-to-digital and digital-to-analog converters. Topic 8. Microprocessor systems architecture. Modular organization of microcontrollers. Von Neumann and Harvard microprocessor architectures. RISC- and CISC-architecture of microprocessors. Storage devices. I / O ports. Controller architecture.	16	10	0	44

1	2	3	4	5
Topic 9. Means of information transmission and processing. Bandpass, notch filters, high and low pass filters. Cyclic code. Hamming code. Gray code. Principles of multichannel signal transmission: channels frequency division, channels time division, channel signals division by shape. Signal transmission via communication channel: industrial information networks; serial interfaces according to RS-232C and RS-485 standards.				
Module 2. Process automation systems in the oil and gas industry. Topic 1. Automatic control systems for technological processes. APCS for an oil and gas production asset (drilling, well workover, production, collection and transportation, preparation, RPM). Integration of various APCS at hardware and software levels. Data collection and transmission architecture from production facilities and reservoir pressure maintenance. Individual and group schemes for collecting data from wells. Data collection and transmission architecture from workover and drilling crews. Remote control of well killing and well top-up during trips. Remote monitoring of wells on production. Remote monitoring of various well flushing from ARPD. Wired and wireless systems for collecting and transmitting data on technological processes. The monitoring and control of contractors work at oil production facilities. Remote control of production facilities (well, AGMU). Adaptive control of a well, a group of wells, and a producing asset. Topic 2. Process control systems. Block diagram of the automated process. Classification of automatic control systems (ACS). Designing systems stages for automatic control of technological processes. Stability, quality, characteristics of ACS. PLC programming languages. Numerical control devices. Topic 3. Automated process control systems of well drilling, oil production, gathering, preparation and pumping. Levels of the automated process control system (APCS): Input / Output level – sensors, actuators and regulating devices; Control level is a data collection and an actuators control using PLC and data received from sensors; Supervisory Control and Data Acquisition Scada is an operational process control system. Levels of an automated enterprise control system (AECS): Manufacturing Execution System (MES) is a production (technology) control system. Manufacturing Resource Planning (MRP) is an enterprise resource control. Enterprise Resource Planning (ERP) is an enterprise resource planning; Business Intelligence (BI) is Business intelligence Systems for process remote monitoring of technological processes in drilling, workover and well	14	8	0	42

1	2	3	4	5
operation in real time. Hardware and software solutions for drilling, workover and production. Digital well. Digital workover. Digital drilling parameter monitoring station. Drilling process automation. Oil production and primary treatment process automation. Gas pumping station work automation				
Conclusion	2	0	0	2
Total with regard to semester	34	18	0	90
Total with regard to the course	34	18	0	90

Topics of exemplary laboratory practice

Sl.№	Topic of laboratory work
1	Studying the device and the principle of pressure and temperature sensors operation
2	Studying the device and the principle of humidity sensors operation
3	Studying the automation principles of a well equipment using a sucker rod pump with a thermometric system
4	Studying the automation principles of the well equipment using an electric centrifugal pump with a thermometric system
5	Studying the automation principles of equipment operation drilling oil and gas wells
6	Studying the automation principles of equipment operation during the oil and gas wells workover

5. ORGANIZATIONAL AND PEDAGOGICAL CONDITIONS

5.1. EDUCATIONAL TECHNOLOGIES USED FOR COMPETENCES FORMATION

Holding lectures in the discipline is based on the active method of training in the process of which students are not passive but active participants of the lesson answering questions of the teacher. Teacher's questions are aimed at activating the process of learning material as well as at the development of logical thinking. The questions stimulating associative thinking and connecting new material with the previous one are identified by the teacher in advance.

Laboratory classes are based on an interactive learning method in which students communicate not only with the teacher but also with each other. At the same time, students ' activity in the learning process dominates. The teacher's place in interactive classes is reduced to orienting students ' activities to achievement of the goals of studies. Interactive lectures, group discussions, role-playing games, training sessions, and analysis of situations and simulation models are used in academic studies

5.2. STUDENTS' MANUAL FOR THE COURSE STUDY

Learning the course students are recommended to fulfill the following positions:

1. Learning of the discipline should be done systematically.

2. After learning one of the course unit with the help of the text-book or lecture notes it is recommended to reproduce in memory the basic terms, definitions, notions of the unit.

3. Special attention should be paid to the reports on practical studies, laboratory works and individual complex tasks for self-work.

4. The topic of questions studied individually is given by the teacher at the lectures. Also the teacher refers to the literary resources (first of all, to the newly published in periodicals) in order the students understand the problems touched on the lectures in detail.

6. LIST OF TEACHING MATERIALS AND INFORMATION SUPPLY FOR STUDENTS' SELF WORK IN THE DISCIPLINE

6.1. PAPER-BASED COURSEWARE

Sl.№	Bibliographic entry (author, title, mode of publication, place, publishing house, year of publication, number of pages)	Number of copies in the library
	1. Basic literature	
1	Giuseppe Menga, V. Kempe, Advances in Informational Aspects of Industrial Automation: Proceedings of the III. Bilateral Meeting GDR-Italy held in Berlin, Berlin: Centr. Inst. Of CyberneticsandInform. Processes, 1985.	1
2	Oil and Gas: Student's Book: in 2 vol. – Oxford: Oxford Univ. Press, 2011.	1
	2. Additional literature	
	2.1. Educational and scientific literature	
1	V. E. Seleznev, S. N. Pryalov, Computational Fluid Dynamics of Trunklines Systems: Methods for Constructing Flow Models in Branched Trunklines and Open Channels / V. E. Seleznev, Moscow: Krasand, URSS, 2014.	5
	2.2. Standardized and Technical literature	
1	L. Lansford, V. D`Arcy, Oil and Gas: Student's Book: in 2 vol.; Vol. 1, Oxford, Oxford Univ. Press, 2011.	129
2	J. Naunton, A. Pohl, Oil and Gas: Student's Book: in 2 vol.; Vol. 2, Oxford, Oxford Univ. Press, 2011.	70
	3. Periodic Literature	
1	International Journal of Offshore and Polar Engineering / Society of Petroleum Engineers, Richardson: Society of Petroleum Engineers, Inc.,1991.	
2	Journal of Petroleum Science and Engineering / Elsevier B.V. – Amsterdam: Elsevier B.V., 1987 – .	
3	Oil & Gas Science and Technology, Revue IFP Energies nouvelles, EDP Sciences, 1974.	
4	SPE Journal, Society of Petroleum Engineers, Richardson: Society of Petroleum Engineers, Inc. 1969.	
	4. Teaching and learning materials for students' self-work	

6.2. ELECTRONIC COURSEWARE

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet/local net; authorized free assess)

6.3. LICENSE AND FREE DISTRIBUTED SOFTWARE USED IN THE COURSE EDUCATIONAL PROCESS

Type of Software	Software branding
OS	Windows 10 (Azure Dev Tools for Teaching)
Office Applications	Adobe Acrobat Reader DC
Image processing software	Corel CorelDRAW Suite X4
General purpose application software	Mathematica Professional Version (license L3263-7820*)
General purpose application software	Microsoft Office Visio Professional 2016 (Azure Dev Tools for Teaching)
General purpose application software	WinRAR (license №879261.1493674)
Management systems for projects, research, development, design, modeling and implementation	Autodesk AutoCAD 2019 Education Multi-seat Stand-alone

6.4. MODERN PROFESSIONAL DATABASES AND INQUIRY SYSTEMS USED IN THE COURSE EDUCATIONAL PROCESS

Branding	Reference to information resource
Scopus database	https://www.scopus.com/
Web of Science Database	https://www.webofscience.com/
Scientific electronic library database (eLIBRARY.RU)	https://elibrary.ru/
Scientific Library of the Perm National Research Polytechnic University	https://lib.pstu/
Lan Electronic Library System	https://e.lanbook.com/
Electronic library system IPR books	https://www.iprbookshop.ru/
Information resources of the Network ConsultantPlus	https://www.consultant.ru/
Company database EBSCO	https://www.ebsco.com/

7. LOGISTICS OF THE COURSE EDUCATIONAL PROCESS

Type of classes	Name of the necessary basic equipment	Number of units
Course Work (CW)	Desks, teacher's table, chairs	30
laboratory work (LW)	Complete computers (system unit, monitor, keyboard, mouse) with Internet access – 15 pieces. Desks, a teacher's table, chairs	15
laboratory work (LW)	Multimedia complex consisting of multimedia – ceiling mount ViewSonic PG705HD projector, SmartBoard 690 interactive whiteboard, acoustic system.	1
Lectures (L)	Multimedia complex consisting of multimedia – ceiling mount ViewSonic PG705HD projector, SmartBoard 690 interactive whiteboard, acoustic system. Desks, a teacher's table, chairs	1

8. FUND OF THE COURSE EVALUATING TOOLS

Described in a separate document

Ministry of Science and Higher Education of the Russian Federation

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FUND OF ESTIMATING TOOLS

For students' midterm assessment in the discipline
"Automation of process controls in oil and gas production"
Supplement to the Academic Course Working Program

Training program	21.03.01Oil and Gas Engineering
Direction (specialization) of educational program	Oil and Gas Engineering
Graduate qualification	Bachelor's degree
Graduate academic chair	Oil and Gas Technology
Form of study	Full-time studies

Year (-s): 4 **Semester (-s)**: 7

Workload:
in credits 4 CU
in hours: 114 h

The form of midterm assessment:
Grading Test: 1 semester

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Fund of estimating tools for midterm assessment of students' learning the subject "Automation of process controls in oil and gas production" is the part (supplement) to the academic course working program. Fund of estimating tools for midterm assessment of students' learning the discipline has been developed in accordance with the general part of the fund of estimating tools for midterm assessment of the basic educational program which determines the system of the midterm assessment results and criteria of putting marks. Fund of estimating tools for midterm assessment of students' learning the subject determines the forms and procedures of monitoring results and midterm assessment of the subject leaning by the students.

1. LIST OF CONTROLLED RESULTS OF STUDYING DISCIPLINE, OBJECTS OF ASSESSMENT AND FORMS OF CONTROL

According to the Academic Course Working Program mastering course content is planned during one semester (the seventh semester of curriculum) and is divided into two educational modules. Classroom activities, lectures and laboratory work as well as students' self-work are provided for every module. In the frames of mastering course content such competences as *to know, to be able, to master* pointed out in the ACWP are formed. These competences act as the controlled results of learning the discipline "Automation of process controls in oil and gas production" (Table 1.1).

Monitoring of the acquired knowledge, abilities and skills is made in the frames of continuous assessment, progress check and formative assessment in the process of studying theoretical material, reports on laboratory works and during examination. Types of control is given in Table 1.1

Table 1.1 – List of controlled results of learning the discipline

Controlled results of learning the discipline (KAS)	**Type of control**					
	Continuous assessment		**Progress check**		**Formative assessment**	
	D	**AC**	**LWR/ PWR**	**T/CW**		**Test**
1	**2**	**3**	**4**	**5**	**6**	**7**
Acquired knowledge						
K.1 Knows the principle of sensors and actuators operation	+			+		+
K.2 Knows algorithms for industrial processes control and their implementation programs	+			+		+
K.3. Knows the operation principle of automatic control systems for industrial processes in the development and operation of oil and gas fields	+			+		+
Acquired abilities						
A.1 Is able to adjust sensors and actuators depending on the specified conditions			+			

1	2	3	4	5	6	7
A.2 Is able to create programs (block diagrams) to monitor the controller			+			
A.3. Is able to create programs (flowcharts) for industrial processes control in the development and operation of oil and gas fields			+			
Mastered skills						
S.1 Masters the skills of using sensors and actuators applied in the oil and gas industry, creation programs (block diagrams) to monitor the controller			+			
S.2 Masters the skills of creation programs (flow-charts) to monitor the controller			+			
S.3 Masters the skills of creation programs (flow-charts) for industrial processes control in the development and operation of oil and gas fields			+			

D – topic discussion; AC –colloquium (discussion of theoretical material, academic conference);CT – case-task (individual task);LWR – report on laboratory work; PWR – report on practical work; T/CW – progress check (control work);TQ – theoretical question; PT – practical task; CT – complex task of grading test.

Final assessment of the learned discipline results is the midterm assessment which is carried out in the form of testing, taking into consideration the results of the running and progress check.

2. TYPES OF CONTROL, STANDARD CONTROL TASKS AND SCALES OF LEARNING RESULTS ASSESSMENT

Continuous assessment of the academic performance is aimed at maximum effectiveness of the educational process, at monitoring students' specified competencies formation process, at increase of learning motivation and provides the assessment of mastering the discipline. In accordance with the regulations concerning the continuous assessment of the academic performance and midterm assessment of students taught by the educational programs of Higher education – programs of the Bachelor's Course, Specialists' and Master's Course the next types of students' academic performance continuous assessment and its periodicity is stipulated in PNRPU:

– acceptance test, check of the student's original preparedness and his correspondence with the demands for the given discipline learning;

– continuous assessment of mastering the material (the level of mastering the component "to know" defined by the competence) at every group studies and monitoring of lectures attendance;

– interim and progress check of students' mastering the components "to know" and "to be able" of the defined competences by computer-based or written testing, control discussions, control works (individual home tasks), reports on laboratory works, reviews, essays, etc.

Discipline progress check is conducted on the next week after learning the discipline module, while the interim control is made at every monitoring during the discipline module study;

– interim assessment, summarizing of the current students' performance at least once a semester in all disciplines for every training program (specialty), course, group;

– controlling of retained knowledge

2.1. CONTINUOUS ASSESSMENT OF EDUCATION

Continuous assessment of learning is made in the form of discussion or selective recitation on every topic. According to the four-point system the results of assessment are put into the teachers' notebook and are considered in the form of integral marks in the process of the midterm assessment.

2.2. PROGRESS CHECK

For the complex assessment of the acquired knowledge, abilities and skills (Table 1.1) progress check is carried out in the form of laboratory and practical work presentations and of midterm control works (after learning every discipline module).

2.2.1. Presentation of laboratory work

It is planned 3 laboratory work all in all. Standard topics of laboratory work are given in ACWP.

Presentation of laboratory work is made by the student individually or by the group of students. Standard scale and criteria of assessment are given in the general part of FET of the educational program.

2.2.2. Midterm control work

According to ACWP 2 midterm control works (CW) is planned to be realized after learning the educational modules of the discipline by the students.

The first CW is realized with respect to the module 1 "Elements and structures of technological process automation systems", the second CW – with respect to the module 2 "Microprocessor technology".

Standard tasks of the first CW:

- Determination of automatic control systems for performing control tasks
- Determination of automatic control systems by purpose

Standard tasks of the second CW:

- Calculation of the capacitive characteristics of perfect soil
- Monitoring of various well flushing from ARPD
- Determination of automatic control systems for technological processes
- Determination of designing systems stages for automatic processes control

Standard scale and criteria of the results of the midterm control work assessment are given in the general part of FET of the educational program.

2.3. FULFILLMENT OF THE COMPLEX INDIVIDUAL SELF-WORK TASK

Individual complex tasks for the students are used for assessment of their skills and abilities acquired in the process of learning the discipline in which the course project or course paper is not stipulated.

Standard scale and criteria of assessment of the individual complex task presentation are given in the general part of FET of the educational program.

2.4. MIDTERM ASSESSMENT (FINAL CONTROL)

Admission for midterm assessment is made according to the results of continuous assessment and progress check. Preconditions for admittance are successful presentation of all laboratory and practice works and positive integral estimation with respect to the results of continuous assessment and progress check.

2.4.1. Midterm assessment procedure without additional evaluation testing

Midterm assessment is made in the form of a test. Credit on the discipline is based on the results of the previously fulfilled by the student individual tasks on the given discipline.

Criteria of putting the final mark for the components of competences in the process of midterm assessment made in the form of test are given in the general part of FET of the educational program.

2.4.2. Midterm assessment procedure followed by evaluation testing

In definite cases (for example, in case of re-attestation of the discipline) midterm assessment in the form of the test on this discipline can be made as the ticket-based evaluation test. Every ticket includes theoretical questions(TQ) aimed at control of the acquired knowledge, practical tasks (PT) aimed at mastered abilities, and complex tasks (CT) aimed at control of the acquired skills of all declared competences.

The ticket is formed so that the included questions and practical tasks could estimate the level of maturity of **all** declared competences.

2.4.2.1. Standard questions and tasks the discipline testing

Standard questions for the acquired knowledge control:

- The operating principle of sensors and actuators;
- Algorithms for industrial processes control and their implementation programs;

- The operation principle of automatic control systems for industrial processes in the development and operation of oil and gas fields.

Standard questions and practical tasks for the mastered abilities control:

- Adjusting sensors and actuators depending on the specified conditions;
- Creation programs (block diagrams) to monitor the controller;
- Creation programs (flowcharts) for industrial processes control in the development and operation of oil and gas fields.

Standard complex tasks for the acquired skills control:

- The skills of using sensors and actuators applied in the oil and gas industry, creation programs (block diagrams) to monitor the controller;
- The skills of creation programs (flowcharts) to monitor the controller;
- The skills of creation programs (flowcharts) for industrial processes control in the development and operation of oil and gas fields.

2.4.2.2. Scales of test assessment of educational achievements

Evaluation of discipline achievements in the form of maturity level of the components *to know, to be able, to master* of the declared competences is made according to the four-point assessment scale.

Standard scale and criteria of estimating educational achievements in the process of testing for the components *to know, to be able, to master* are given in the general part of FET of educational program.

3. ASSESSMENT CRITERIA FOR COMPONENTS AND COMPETENCES LEVEL OF MATURITY

3.1. ASSESSMENT OF COMPETENCES COMPONENTS LEVEL OF MATURITY

While estimating the level of competences maturity by selective control in the process of testing it is considered that *the mark obtained for the components of the examined competence is combined with the corresponding component of all competences formed in the frames of the given academic course.*

General assessment of maturity level of all competences is made by aggregation of marks obtained by the student for each component of the formed competences taking into account the results of continuous assessment and progress check in the form of integral mark according to the four-point scale. All control results are put into the assessment sheet by the teacher according to the results of midterm attestation.

The form of the assessment sheet and requirements for its completion are given in the general part of FET of the educational program.

While making the final assessment of the midterm attestation in the form of test standard criteria given in the general part of FET of the educational program are used.