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
25 03 20 21

ACADEMIC COURSE WORKING PROGRAM

Academic course: Reservoir engineering
(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): 252 (7)
(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)

Perm 2021

1. GENERAL PROVISIONS

1.1. GOALS AND OBJECTIVES OF THE COURSE

The goal of the course is to form a complex of knowledge in the field of reservoir engineering.

The objectives of the course are:

– to know the system of liquid and gaseous hydrocarbon fields development and operation;

– to be able to use methods for determining the development of hydrocarbon fields systems;

– to master the skills of using the methods ensuring the operational state of the systems' elements for the liquid and gaseous hydrocarbon fields development and operation.

1.2. STUDIED OBJECTS OF THE COURSE

– Hydrocarbon fields.

– Geological and physical occurrence conditions of hydrocarbon fields.

– Mechanisms of liquid and gaseous hydrocarbon fields production.

– Well pattern.

– Methods for technological calculations in reservoir engineering.

– Assessment algorithms for the technological efficiency of reservoir engineering.

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 be able to, to master)	Indicator of Attaining Competence which the planned results of training are correlated with	Means of Assessment
1	2	3	4	5
PC-3.2.	**IA-1**$_{pc\text{-}3.2}$	**To know:** – relevant scientific research problems of reservoir engineering; – the experience of solving reservoir engineering problems by scientific research; – research methods of reservoir engineering phenomena;	**Knows** the general directions of scientific research in the O&G industry.	Discussion, Control work, Exam

1	2	3	4	5
		– types of theoretical, laboratory and numerical of reservoir engineering phenomena research; – technological processes of hydrocarbon production; – technologies for assessing the field productivity increase; – well operation modes, well operation parameters; – methods and means of well stimulation; – parameters of the field geological model; – physical and chemical properties of hydrocarbons.		
PC-3.2.	**IA-2**$_{pc\text{-}3.2}$	**To be able to**: – carry out a scientific search on a certain reservoir engineering problem using scientific journals; – assess the relevance of the problems to determine the study's goal and objectives to meet the O&G industry needs; – evaluate the effectiveness of existing solutions to solve a certain problem; – perform own calculations for solving a certain problem; – analyze and summarize the data of technological equipment operation during the research; – prepare a research report for conferences and seminars; – present the research report at conferences and seminars; – process the reservoir performance data.	**Is able to** prove the relevance and goals of own research with its further presentation at the conferences and seminars; make scientifically-grounded reports on the O&G industry problems.	Course Project
PC-3.2.	**IA-3**$_{pc\text{-}3.2}$	**To master** the skills of: – making presentation including the research goals, objectives, methods and results; – processing the scientific research results (initial data for a presentation) in the form of diagrams, graphs, tables, figures, and animation; – using specialized software packages (Microsoft PowerPoint etc.) to make a	**Has mastered** the skills of using the methods of delivering the research results in the form of electronic presentation.	Report on practical work.

1	2	3	4	5
		electronic presentation; – using specialized software products; – holding the target audience attention in the process of presenting the research results.		
PC-4.1.	**IA-1$_{pc-4.1}$**	**To know:** – the complex methods of drawing up and proving the schemes and projects based on rational use of natural resources; – the methods of differential and integral calculus, numerical modeling in design; – the well operation modes, well operation parameters; – the principles of using software packages, including field-packages for calculating technological processes during reservoir engineering; – the impact of various reservoir processes on the well productivity index; – methods for performing technical calculations and determining the efficiency of operating equipment for hydrocarbons extraction; – production indicators of reservoir engineering, the diagram of field development.	**Knows** the mechanism and technology of designing technological processes, production technological complexes, systems of supervisory control (monitoring), geological and technical control, and etc., standard computer programs for engineering tools and technological solutions calculation	Report on practical work. Exam
PC-4.1.	**IA-2$_{pc-4.1}$**	**To be able to:** – analyze the reservoir engineering system efficiency stated in the technological documentation; – evaluate the current reserves production rate, oil and gas field recovery factors in comparison with the ones in the project plan; – perform analysis of oil and gas wells operation efficiency, geological and technical measures for increasing oil and gas production with software packages; – generalize experience of production intensification methods in specific geological conditions;	**Is be able to** analyze and summarize the experience of designing engineering and technological projects, apply standard software at designing production and technological processes in the O&G industry	Course Project

1	2	3	4	5
		– use the reports on monitoring reservoir engineering and well operation; – evaluate the effectiveness of technological solutions to improve field development efficiency.		
PC-4.1.	**IA-3**$_{pc-4.1}$	**To master** the skills of: – working with state standards and regulatory documents in designing the reservoir engineering; – acquiring, processing and using the field data to prepare separate parts of technological projects on reservoir engineering; – oil and gas production technological calculations for the design of technological equipment operating modes used in reservoir engineering; – using the monitoring results of reservoir engineering and well operation.	**Has mastered** the skills of designing the definite engineering and technological projects' parts.	Report on practical work.
PC-4.2	**IA-1**$_{pc-4.2}$	**To know**: – state standards of reservoir engineering design (GOST 32359-2013, GOST R 55415-2013); – rules for hydrocarbon reservoirs engineering (Order of the Ministry of Natural Resources of the Russian Federation No. 356 dated June 14, 2016); – rules for technical projects of hydrocarbon reservoirs engineering, in particular: projects of field trial production, technological reservoir engineering schemes, technological reservoir engineering projects (Order of the Ministry of Natural Resources of the Russian Federation No. 639 dated 20 September 2019); – design content of technological documentation, geological, technological and economic parts of the reservoir engineering; – data sources for the project documentation development.	**Knows** regulations, standards, standing instructions, and methods of designing in the O&G industry.	Exam

1	2	3	4	5
PC-4.2	**IA-2$_{pc-4.2}$**	**To be able to**: – perform standard calculations of productive formations and well pattern arrangements, reservoir pressure changes in field development; – perform technological parameters calculations of water flooding using computer-aided design; – calculate the reservoir engineering production indicators in modern software packages for hydrodynamic modeling; – formalize the calculation results of technological design and modeling software packages for preparing reservoir engineering technological projects' parts; – prepare technical projects for reservoir engineering; – forecast the changes of fluid inflow characteristics from the formation to the well taking into account the production mechanism.	**Is able to** develop standard designs, technological and working documentation using CAD technological processes.	Course Project
PC-4.2	**IA-3$_{pc-4.2}$**	**To master** the skills of: – geological reserves calculation, initial recoverable reserves calculation, current oil and gas reserves calculation by the material balance method using modern computer design software packages; – oil and gas wells flow rate calculation using innovative software products; – production indicators calculation of reservoir engineering at compaction drive and water production drive mechanisms of the O&G fields; – monitoring and control of field and well operation.	**Has mastered** the skills of innovative methods for solving technological and production processes design objectives in the O&G industry.	Report on practical 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
		6
1. Holding classes (including results monitoring) in the form: 1.1. Contact classwork, including:	91	91
– lectures (L)	45	45
– laboratory work (LW)		
– practice, seminars and/or other seminar-type work (PW)	36	36
– control of self-work (CSW)	10	10
– test		
1.2. Students' self-work (SSW)	125	125
2. Intermediate attestation		
Exam	36	36
Grading test		
Test (Credit)		
Course Project (CP)	36	36
Course Work (CW)		
Workload in hours	**252**	**252**

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 6				
Introduction.	2	0	0	2
The objectives and the content of the course. The history of reservoir engineering science development. Goals and objectives of reservoir engineering processes. Basic concepts and definitions (oil field, oil reservoir, etc.). Classification of oil and gas fields. Categories of oil reserves.				
Module 1. Oil reservoir engineering	26	0	22	73
Geological and physical characteristics of oil fields Types of reservoirs. Effective oil pay thickness. Reservoir pressure and temperature. Oil saturation of rocks. Porosity. Permeability. Gross sand ratio. Bedding ratio. Saturation pressure of oil with gas. Oil viscosity and density. Productivity. Properties and composition of formation water and associated gas. Oil field energy characteristics. Reservoir pressure as the main oil reservoir energy indicator. Forces acting in the reservoir. Mechanisms of oil field natural production– primary recovery methods.				

1	2	3	4	5
Productive formation and well pattern arrangement The definition of productive formation. Allocation of productive formation: approaches and justification. Joint production from several productive formations: advantages and disadvantages. The procedure for starting reservoir production. Well pattern arrangements. Parameters of well patterns. Classification. Reservoir engineering at natural production mechanisms. Reservoir pressure maintenance systems.				
Production indicators of oil reservoir engineering Technological indicators of oil reservoir engineering: annual and accumulated, determination formulas. Well flow rate. Oil recovery factor: types and methods of determination. Areal sweep efficiency and displacement efficiency. Stages of oil field development. The field development diagram.				
Reservoir heterogeneity Types of heterogeneity. Micro and macro inhomogeneity. Indicators of heterogeneity. Methods for studying geological heterogeneity. Relative gross sand ratio. Bedding ratio. Lithological connectivity coefficient. Pinch-out coefficient. Reservoir engineering problems solved by studying the heterogeneity.				
Reservoir modeling Basic definitions in computer modeling. The model. Requirements to the model. Geological and hydrodynamic model of an oil reservoir. The main stages of hydrodynamic modeling. Probabilistic and statistical model. Homogeneous reservoir model. Layered reservoir model. Model of fractured and fractured-porous reservoir. Physical model. Upscaling. Model calibration.				
Reservoir engineering at natural production mechanisms. Compaction drive Compaction drive. Areas of application. Continuity equations. Darcy flow equation. The equation of porous medium and elastic fluid state. Piezo Conductivity. Elastic reserve of a reservoir. Compressibility of rocks and formation fluids. Closed compaction drive. Compaction-water drive. Van Everdinger-Hurst problem. Duhamel integral. Zheltov's solution for variable flow rate.				
Oil reservoir engineering at natural production mechanisms. Solution gas drive The phase envelope. Saturation pressure of oil and gas reservoir. Oil volumetric ratio. Gas factor. Phase permeability diagram. Inflow calculation of liquid saturated with gas. Gas solubility coefficient. Compressibility of oil gas. Quasi-stationary mode of changing gas factor and oil saturation on the supply contour with a stepwise pressure decrease.				

1	2	3	4	5
Waterflooding of oil reservoirs Types of waterflooding and their applications. Criteria of application. Features of oil-water zones development. Injection pressure optimization during waterflooding. Requirements for water during flooding. The mechanism of water-oil displacement. The ideal (piston-like) and non-ideal displacement. The role of capillary forces in the water-oil displacement. Non-stationary waterflooding.				
Material balance equation The linear form of the material balance equation. Application of the material balance method for assessing oil reservoir engineering parameters. Oil expansion. Expansion of the released gas (into the gas cap). Gas expansion of the gas cap. Changes in the hydrocarbons volume.				
Hydrodynamic calculations of flow rates and pressure in injected water drive Kinematics of filtration flows. External and internal flow resistance. Calculation of filtration changes. Borisov's method. Assumptions. Analogy with the second Kirchhoff's law. Integration of oil and water viscosity and changes' resistance in the displacement zone. Current water injection front location. Time calculation of the water front approaching the production well.				
Improved recovery and well stimulation Secondary (IOR) and tertiary (EOR) recovery methods. Methods of production increase (MPI). Classification of MPI by the type of displacing agents and by the scale of impact. Applicability criteria. Thermal, gas, chemical, hydrodynamic, and combined MPI. MPI screening and roadmap. Well stimulation methods. Classification. Well treatment methods.				
Field development management Oil field development methodology. Reserves calculating methods. Choosing a production strategy. Production optimization. Reservoir productivity. Surface and downhole production limiting factors. Skin factor. Pressure drawdown. Sand production. Oil field development rate.				
Content of project documentation Oil field development methodology. Reserves calculating methods. Choice of a production strategy. Production optimization. Reservoir productivity. Surface and downhole production limiting factors. Skin factor. Pressure drawdown. Sand production. Oil field development rate.				
Module 2. Gas reservoir engineering	16	0	14	50
Geological and physical gas field characteristics Component composition, physical and chemical				

1	2	3	4	5
properties of natural gas. Types of natural gas: dry, wet, and gas condensate. Classification of gas fields. Acting forces in the reservoir. Mechanisms of gas reservoir production. Energy characteristics changes of deposit development.				
Productive formation and well pattern arrangement Allocation of productive formations. Well pattern arrangement in the gas content area. Features of the gas reservoir engineering. The movement of gas, condensate and water in the reservoir.				
Oil reservoir engineering production indicators Technological indicators of gas field development. Gas field development schedule. Estimation of initial and residual gas reserves. Gas well production rate. Calculation of development indicators in gas mode. Forecast calculation of condensate production and formation losses.				
Material balance equation The main mechanism of gas production from a gas reservoir. Gas volume changes during its transition from reservoir to surface conditions. Supercompressibility coefficient. Gas flow mode of gas reservoirs. Elastic water-pressure mode of gas and gas condensate deposits.				
Gas movement and formation water in gas reservoirs Filtration law in near-wellbore zones. Curvature of flowlines. Two-phase filtration (gas-condensate mixtures), well production rates limit in order to prevent the destruction of near-wellbore formation. Calculation of edge water advancement into a gas reservoir. Calculation of bottom water invasion into a massive gas reservoir.				
Methods for increasing gas recovery Methods of bottomehole formation zone (BHFZ) treatment. Factors for choosing the methods. Methods of gas well treatment. Classification.				
Gas condensate reservoir engineering Phase transformations of gas-condensate mixtures. Calculation of differential condensation process of natural gas-condensate mixtures. The minimum required gas flow rate for complete condensate removal from the well bottom. Maintaining the reservoir pressure. Injection of dry (stripped) gas and water into the reservoir.				
Field development management Gas field development methodology. Methods of reserves calculation. Choosing a mining strategy. Production optimization. Reservoir productivity. Surface and downhole limiting production factors. Skin factor. Pressure drawdown. Sand production. Gas field development rate. Control features of gas condensate fields development.				

1	2	3	4	5
Conclusion.	1	0	0	0
Regulatory and technical documentation of hydrocarbon raw material extraction. Summing up the results of course studying.				
Total with regard to 6th semester	45		36	125
Total with regard to the course	45		36	125

Topics of exemplary practical work

Sl.№	Topic of practical (seminar) work
1.	Determination of producing wells number at the productive formation for oil reserves maximum recovery.
2.	Calculation of pressure changes in the reservoir during the well operation.
3.	Using the material balance method to determine the initial geological oil reserves.
4.	Determination of pressure at the production and injection wells bottom.
5.	Calculation of the production well flow rate and the injectivity of the well.
6.	Determination of oil well recovery factor and perforation interval.
7.	Calculation of the water front approaching time and oil well watering time.
8.	Calculation of edge and bottom water advancement into a gas reservoir.
9.	Determination of initial gas reserves for a gas and gas condensate field.

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.

Practical lessons are held by realization of the method based on active training: problem areas are determined, groups are formed. The following aims are pursued in the process of practical education: use of definite disciplines knowledge and creative methods in solving problems and decision-making; students' skill-building of teamwork, interpersonal communication and development of leadership skills; consolidation of the basic theoretical knowledge.

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, it is advisable for students to implement the following recommendations:

1. Learning of the discipline should be done systematically.

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

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

4. The topics list for individual study is given by the teacher at the lectures. The teacher also provides students with literary sources (first of all, new ones in the periodical scientific literature) for a more detailed understanding of the issues presented at the lectures.

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	**2**	**3**
	1. Basic literature	
1.	Dake L.P. Fundamentals of Reservoir Engineering. ELSEVIER, Amsterdam, Netherlands, 498 p.	
2.	William C.L., Gary J.P., Michael D.L., Standard Handbook of Petroleum and Natural Gas Engineering. Third Edition. Elsevier, Oxford, UK, 1817 p.	
3.	Vol. 1/L. Lansford, V. D`Arcy. – Oxford: Oxford Univ. Press, 2011. – (Oil and Gas: Student's Book: in 2 vol.; Vol. 1).	40
4.	Vol. 2/J. Naunton, A. Pohl. – Oxford: Oxford Univ. Press, 2011. – (Oil and Gas: Student's Book: in 2 vol.; Vol. 2).	35
5.	Ezekwe N. Petroleum Reservoir Engineering Practice. Pearson Education, Boston, MA, USA, 801 p.	
6.	Jawad R.R., Mohamedali S.A., Jirjees A.Y., Sajad S., Namiq M. Reservoir engineering handbook, Alassal Kirkuk U. 241 p.	
	2. Additional literature	
	2.1. Educational and scientific literature	
7.	Heinemann Z. Fluid Flow in Porous Media, Leoben, Austria, PHDG, 2005, 206 p.	
8.	Selley R.C., Morill D.C. Fundamentals of Petroleum Geology, IHRDC, Boston, USA, 1983, 98 p.	
9.	Terry R.E., Rogers J.B. Applied Petroleum Reservoir Engineering. Third Edition, Prentice Hall, 2014	
10.	Reiss L.R. The Reservoir Engineering Aspects of Fractured Formation, Editions TECHNIP, 1980	1
11.	Youssef N., Elshahed M.S., McInerney M.J. Microbial Processes in Oil Fields: Culprits, Problems and Opportunities, Vol 66, Burlington: Academic Press, 2009, pp. 141-251.	
12.	Chilingarian G.V. Developments in Petroleum Science, Elsevier Science Publishers, 1989, 607 p.	

1	2	3
2.2. Standardized and Technical literature		
13.	American Society for Testing and Material (ASTM) D4530 – 15 "Standard Test Method for Determination of Carbon Residue (Micro Method)"	
14.	Safety Case Regulations, UK	
15.	ISO/IEC JTC1/SC 32 "Data management and interchange"	
16.	ISO/TC 67 "Materials, equipment and offshore structures for petroleum and natural gas industries"	
17.	Penny, J., Eaton, A., Bishop, P. G., & Bloomfield, R. E. (2001). The practicalities of goal-based safety regulation. In Aspects of Safety Management (pp. 35-48). Springer London	
18.	NORSOK D-010: "Application of technical, operational and organisational solutions to reduce risk of uncontrolled release of formation fluids throughout the lifecycle of a well."	
19.	SPE – PRMS 2007	
20.	Demirmen, F. (2007). Reserves estimation: the challenge for the industry. Journal of Petroleum Technology, 59(05), 80-89.	
21.	Journal of Petroleum Science and Engineering, ISSN: 0920-4105, 1987-present	
22.	SPE Production & Operations, ISSN 1930-1863, 2006-present	
23.	SPE Production Engineering, ISSN 1930-1863, 1986-1992	
24.	Journal of Petroleum Technology, ISSN: 1944-978X,1949-present	
3. Students' manual in mastering discipline		
25.	Ahmed T. Reservoir Engineering Handbook. Fourth Edition, Elsevier, 2010, 1472 p.	
26.	Hatami M.J. Oilfield Survival Guide, Volume One: For All Oilfield Situations 1st Edition, Oklahoma, USA, 2016. 313 p.	
4. Teaching and learning materials for students' self work		
27.	Satter A., Iqbal G.M. Reservoir Engineering. 1st Edition. The Fundamentals, Simulation, and Management of Conventional and Unconventional Recoveries, 2015, 486 p.	
28.	Miskimins J. Hydraulic Fracturing: Fundamentals and Advancements, 2019, 795 p.	
29.	Ertekin T., Sun Q., Zhang J. Reservoir Simulation: Problems and Solutions, 2019, 608 p.	

6.2. ELECTRONIC COURSEWARE

Kind of literature	**Name of training tool**	**Reference to information resource**	**Accessibility of EBN (Internet/ local net; authorized/ free access)**
1	**2**	**3**	**4**
Basic	Dake L.P. Fundamentals of Reservoir Engineering. ELSEVIER, Amsterdam, Netherlands, 498 p.	http://www.ing.unp.edu.ar/asignaturas/reservorios/Fundamentals%20of%20Reservoir%20Engineering%20%28L.P.%20Dake%29.pdf	Free access
Basic	Ezekwe N. Petroleum Reservoir Engineering Practice. Pearson Education, Boston, MA, USA, 801 p.	http://docshare02.docshare.tips/files/31481/314819498.pdf	Free access

1	2	3	4
Additional	Heinemann Z. Fluid Flow in Porous Media, Leoben, Austria, PHDG, 2005, 206 p.	https://pure.unileoben.ac.at/portal/files/561552/Fluid_flow_in_porous_media.pdf	Free access
Additional	Terry R.E., Rogers J.B. Applied Petroleum Reservoir Engineering. Third Edition, Prentice Hall, 2014	https://ptgmedia.pearsoncmg.com/images/9780133155587/samplepages/9780133155587.pdf	Free access

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 Perm National Research Polytechnic University	https://lib.pstu/
Lan' Electronic Library System	https://e.lanbook.com/
IPRbooks Electronic Library System	https://www.iprbookshop.ru/
Information resources of ConsultantPlus Network	https://www.consultant.ru/
EBSCO Company Database	https://www.ebsco.com/

7. LOGISTICS OF THE COURSE EDUCATIONAL PROCESS

Type of classes	Name of the necessary basic equipment	Number of units
Course project	Complete computer system (system unit, monitor, keyboard, mouse) with Internet access.	15
Lecture	Complete computer system (system unit, monitor, keyboard, mouse) with Internet access.	1
Lecture	Multimedia complex: multimedia – projector, interactive whiteboard, acoustic system.	1
Practical lesson	Complete computer system (system unit, monitor, keyboard, mouse) with Internet access.	15

8. FUND OF THE COURSE EVALUATING TOOLS

Described in a separate document

Ministry of Science and Higher Education of the Russian Federation
Federal State Budgetary Educational Institution of Higher Education
"Perm National Research Polytechnic University"

FUND OF ESTIMATING TOOLS

For students' midterm assessment in the discipline
"Reservoir engineering"
Supplement to the Academic Course Working Program

Training program	21.03.01 Oil 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: 3 **Semester**: 6

Workload:
in credits: 7 CU
in hours: 252 h

The form of midterm assessment:
Exam – 6 semester **Course Project** – 6 semester

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Fund of estimating tools for midterm assessment of students' learning the subject "Reservoir engineering" 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 sixth semester of curriculum) and is divided into two educational units. Classroom activities, lectures, practice 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 (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/CP	T/CW	E
1	2	3	4	5	6
Acquired knowledge					
Knows general research directions in the O&G industry.	D			T/CW	E
Knows the mechanism and technology of designing technological processes, technological complexes used in production, in particular, systems of supervisory control (monitoring), geological and technical control, etc., standard computer programs for engineering tools and technological solution calculation.	D			T/CW	E
Knows regulations, standards, standing instructions, and methods of designing in the O&G industry.	D			T/CW	E

1	2	3	4	5	6
Acquired abilities					
Is able to define the research relevance and goals with the further presentation at conferences and seminars; to make scientifically-grounded reports on the problems of the O&G industry.			CP		
Is able to analyze and summarize the experience of engineering and technological projects, to apply standard software at production and technological processes design in the O&G industry			CP		
Is able to develop standard designs, technological and working documentation of technological processes with CAD.			CP		
Mastered skills					
Has mastered the skills of delivering the research results in the form of electronic presentation.			PWR		
Has mastered the skills of designing definite engineering and technological projects' parts.			PWR		
Has mastered the skills of innovative methods for solving the objectives of technological and production processes design in the O&G industry.			PWR		

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; E – exam; CP – Course Project.

Final assessment of the learned discipline results is the midterm assessment which is made in the form of test 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;

– retained knowledge control.

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' note-book and are considered in the form of integral mark 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) it is made the progress check in the form of practice work presentation and midterm control works (after learning every discipline module).

2.2.1. Presentation of practical work

It is planned 18 practical work all in all. Standard topics of practical work are given in ACWP.

Presentation of practical 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) are planned to be realized after learning the educational modules of the discipline by the students.

The first CW is realized on module 1 "Oil reservoir engineering", the second CW – on module 2 "Gas reservoir engineering".

Standard tasks of the first CW:

Well stock is
1.the total number of injection and reserve wells;
2. the total number of reserve and production wells;
3. the total number of suspended wells;
4. the total number of production and injection wells.

Well production water cut is determined by the ratio of
1. water extraction to liquid extraction;
2. water extraction to oil extraction;
3. oil production to water production;
4. water injection to production fluid.

Compensation for fluid withdrawal by water injection is determined by the ratio of
1. injected volume to initial recoverable reserves;
2. produced water volume to produced liquid volume;
3. injected water volume to the withdrawn fluid volume;
4. produced water volume to the injected water volume.

Low viscosity oils include reservoir viscosity
1. up to 10 mPas;
2. up to 2 mPas;
3. up to 1 mPas;
4. up to 50 mPas.

The negative aspect of areal flooding is
1. reduction of well injectivity;
2. the difficulties in regulating the water movement to production wells;
3. the reduced rates of reservoir development;
4. low grid density of wells.

Selective waterflooding involves
1. uniform distribution of production and injection wells over the area along a uniform grid in a certain sequence;
2. uniform distribution of injection wells over the area along a uniform grid in a certain sequence;
3. purposeful selection of the injection wells location, according to the reservoir geological structure;
4. wells location behind the outer contour of oil-bearing capacity.

Oil recovery factor for systems with reservoir pressure maintenance
1. has the same values as when developed in natural mode;
2. is at least twice as much as when developed in natural mode;
3. is less than when developed in natural mode;
4. is more than when developed in natural mode.

With a five-spot development system, the ratio of production wells to injection wells is
1. 1 to 1;
2. 2 to 1;
3. 1 to 5;
4. 3 to 1.

With a seven-point direct development system, the ratio of production wells to injection wells is
1. 1 to 1;
2. 2 to 1;
3. 3 to 2;
4. 3 to 1.

Standard tasks of the second CW:

The addition of surfactant to the injected water is effective if oils has viscosity of
1. more than 100 mPas;
2. less than 5 mPas with a reservoir permeability of more than 30 mD;
3. less than 5 mPas for low-permeability reservoirs;
4. 5-30 mPas with a reservoir permeability of more than 30 mD.

The addition of micellar solutions to the injected water is used
1. for oils with viscosity of more than 100 mPas;
2. to recover residual oil from flooded reservoirs;
3. for oils with viscosity of less than 1 mPas;
4. at the initial stages of field operation in order to intensify oil production.

Waterflooding methods are ineffective in reservoir development
1. for oils with viscosity of more than 50 mPas;
2. when recovering residual oil comes from flooded formations;
3. for oils with viscosity of less than 1 mPas;
4. with low initial reservoir pressure.

Steam displacement can be recommended in reservoir conditions

1. for oils with viscosity of more than 100 mPas;
2. for oils with viscosity of 40-50 mPas;
3. for oils with viscosity of less than 1 mPas;
4. with low initial reservoir pressure.

The license is a document certifying the owner's right to use the subsoil plot

1. in certain boundaries according to the specified goal during a set period, subject to the pre-agreed requirements and conditions;
2. throughout the territory of the Russian Federation according to the specified purpose within a specified period, subject to previously agreed requirements and conditions;
3. in certain boundaries without certain conditions within a specified period, subject to the previously agreed requirements and conditions;
4. in certain boundaries according to the specified purpose for any period of time, subject to the previously agreed requirements and conditions.

Mountain allotment is

1. field area in plan;
2. allocation of land for wells;
3. total area inside well boundaries;
4. geometrized subsoil block provided for the development of oil and gas fields.

Operating costs include

1. tax fees;
2. well service, maintenance of reservoir pressure, oil and gas production and transportation, oil technological preparation, well workover, and well depreciation;
3. only depreciation deductions;
4. well drilling and field infrastructure.

Typical scale and criteria for assessing the results of midterm control work are given in the general part of the FET of the specialist's program.

2.3. FULFILLMENT OF THE COMPLEX INDIVIDUAL SELF-WORK TASK

Individual complex task for the students is used for assessment 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 practice works and positive integral estimation with respect to the results of continuous assessment and progress check.

Midterm certification, according to the ACWP, is carried out in the form of a discipline exam orally using tickets. The ticket contains 3 theoretical questions (TQ) to test the acquired knowledge.

The ticket is formed in such a way that it contains questions that control the level of formation of all declared disciplinary competencies. The ticket form is presented in the general part of the FET of the undergraduate program.

2.4.1 Typical questions to control the acquired knowledge:

- Composition and properties of fluids and host rocks formation.
- Energy characteristics of oil fields.
- Technological indicators of oil field development.
- Dynamics of development indicators.
- Concept of the operational facility.
- Development of multilayer oil fields.
- Systems of oil fields development under natural conditions.
- Oilfield development systems during waterflooding.
- Thermal methods of enhanced oil recovery.
- Gas methods of enhanced oil recovery.
- Chemical methods of enhanced oil recovery.
- Hydrodynamic methods of enhanced oil recovery.
- Oil field development control.
- Regulation of oil field development.
- Legislative norms of the Russian Federation in the field of subsoil and hydrocarbon production.
- Environmental protection of oil fields development.
- Economic effectiveness evaluation of oil field development.
- Tax obligations of an enterprise – a subsoil user.

Note. A complete list of theoretical questions in the form of an approved set of examination tickets is kept at the issuing department.

2.4.2 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.