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: Production geology
(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): 108 (3)
(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 goal of the course is to determine the most rational and effective technologies and basic technical means in hydrocarbon deposits development in productive formations with different geological, geophysical properties and geological structure.

As a result of the course the student:

• knows the geological methods of obtaining geological object's data; principles of static and dynamic geological objects modeling; energy characteristics of deposits; physical forces and processes that form natural modes and thermobaric models of hydrocarbon deposits;

• is able to systematize geological and field data of a method complex for studying the reservoirs parameters, to define formation fluids and hydrocarbon deposits; to analyze the influence of a geological-physical and geological-field factors complex for hydrocarbon extraction from productive layers;

• has mastered the skills of the methodology for reasoning the choice of a rational system for hydrocarbon fields development based on a complex of geological and field data.

1.2. STUDIED OBJECTS OF THE COURSE

Static and dynamic reservoir model; natural conditions in oil and gas fields, methods of their study and display; forces and processes in layers during their development; oil field development systems; development system design.

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-1.1.	**IA-1 PC-1.1.**	**To know** the basic production processes in O&G operation.	**Knows** the basic production processes in O&G operation.	Interview of practical tasks
	IA-2 PC-1.1.	**To be able to** correct technological process in coordination with service companies and technical service specialists in real situations.	**Is able to** correct technological process in coordination with service companies and technical service specialists in real situations.	Report on practical work

1	2	3	4	5
	IA-3 PC-1.1.	**To master the skills** of production processes management using modern equipment and materials.	**Masters the skills** of production processes management using modern equipment and materials.	Test
PC-3.1.	**IA-1 PC-3.1.**	**To know** the methods of data analysis concerning the technological processes and operation of technological devices in O&G industry.	**Knows** the methods of data analysis concerning the technological processes and operation of technological devices in O&G industry.	Interview
	IA-2 PC-3.1.	**To be able to** plan and conduct necessary experiments including those in which software is applied, interpret the results and draw appropriate conclusions.	**Is be able** to plan and conduct necessary experiments including those in which software is applied, interpret the results and draw appropriate conclusions.	
	IA-3 PC-3.1.	**To master the skills** of using physical and mathematical apparatus to solve computational and analytical tasks in professional activity.	**Has mastered the skills** of using physical and mathematical apparatus to solve computational and analytical tasks in professional activity.	

3. FULL TIME AND FORMS OF ACADEMIC WORK

Form of academic work	**Hours in all**	**Distribution in hours according to semesters**		
		Number of semester		
			2	
1. Holding classes (including results monitoring) in the form: 1.1.Contact classwork, including:	38		38	
– lectures (L)	18		18	
– laboratory work (LW)				
– practice, seminars and/or other seminar-type work (PW)	18		18	
– control of self-work (CSW)	2		2	
– test				
1.2. Students' self-work (SSW)	34		34	
2. Intermediate attestation				
Exam	36		36	
Grading test				
Test (Credit)				
Course Project (CP)				
Course Work (CW)				
Workload in hours	**108**		**108**	

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
Semester 1				
Module 1. Properties of hydrocarbon deposits in natural conditions and methods for studying reservoirs and fluids.	6		6	10
Module 2. Geological foundations of hydrocarbon fields development.	6		6	12
Module 3. Static and dynamic modeling of hydrocarbon deposits as development objects.	6		6	12
Total with regard to 1st semester	18		18	34
Total with regard to the course	18		18	34

Topics of exemplary practical work

Sl.№	Topic of practical (seminar) work
1	Definition of the deposit natural mode type.
2	Construction of the field geological section.
3	Field development stages.
4	Calculation of fluid inflow to a well according to Dupuis's law.
5	Application of mathematical statistics methods to analyze the field development.
6	3D geological modeling.
7	3D hydrodynamic modeling.

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 formulated 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. Basic literature	
1.	Bjørlykke, Knut Petroleum Geoscience: From Sedimentary Environments to Rock Physics; Springer Heidelberg Dordrecht London New York, 2015	eBook https://elib.pstu.ru/EdsRecord/edssjb,edssjb.978.3.642.34132.8.1
	2. Additional literature	
	2.1. Educational and scientific literature	
2	Guan, Defan, Xu, Xuhui, Li, Zhiming, Zheng, Lunju, Tan, Caiping, Yao, Yimin Brief Review of Petroleum Geology Theory Development // Theory & Practice of Hydrocarbon Generation within Space-Limited Source Rocks; 2017, p. 1-17	eBook https://elib.pstu.ru/EdsRecord/edssjb,edssjb.978.981.10.2407.8.1
3	Fanchi, John R., Christiansen, Richard L. PETROLEUM GEOLOGY//Introduction to Petroleum Engineering; 2016, p. 101-117	eBook https://elib.pstu.ru/EdsRecord/edb,118592100
	2.2. Standardized and Technical literature	
		–
	3. Students' manual in mastering discipline	
		5
	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 access)
Scientific electronic library	Scientific electronic library database (eLIBRARY.RU)	https://elibrary.ru/	authorized free access
Scientific electronic library	Scientific Library of Perm National Research Polytechnic University	https://lib.pstu/	Internet

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
Reservoir simulator	Tempest More (Roxar) (education license)
Reservoir simulator	T-Navigator (education license)
Geological modeling simulator	Irap RMS (Roxar) (education license)

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/
IPR books Electronic library system	https://www.iprbookshop.ru/
Information resources of the Network ConsultantPlus	https://www.consultant.ru/
Company database EBSCO	https://www.ebsco.com/
Mineral's catalog	https://catalogmineralov.ru/
BSGF – Earth Sciences Bulletin	https://www.bsgf.fr/

7. LOGISTICS OF THE COURSE EDUCATIONAL PROCESS

Type of classes	Name of the necessary basic equipment	Number of units
Lecture	Multimedia Projector	30
Modeling laboratory class	Computer equipment	30
Laboratory class	Rocks and Minerals samples	30

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
"Production geology"
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 (-s): 1 **Semester (-s)**: 1

Workload:
in credits: 3 CU
in hours: 108 h

The form of midterm assessment:
Exam 2 semester

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Fund of estimating tools for midterm assessment of students' learning the subject **"Production geology"** 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 first semester of curriculum) and is divided into four 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 (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 characteristics of reservoirs heterogeneity and filtration-capacity properties, formation of fluids properties	D			CW1		D
K.2 Knows the conditions for modes and features formation of the deposits development, grid of well placement, types and varieties of reservoir flooding	D			CW1		D
K.3. Knows the stages of hydrocarbon fields development	D			CW2		D
K.4 Knows the categories of oil and gas reserves and resources		AC		CW2		D
K.5 Knows the dynamics of changes in the main field development parameters		AC		CW3		D

1	2	3	4	5	6	7
K.6. Knows the basic principles of geological and hydrodynamic modeling		AC		CW3		D
Acquired abilities						
A.1 Is able to evaluate the heterogeneity indicators and degree of reservoir properties and reservoir fluids properties		AC		CW1		PT
A.2 Is able to determine the forces that form the modes and select the methods of well placement and the water flooding type, taking into account the geological and production characteristics of reservoirs and fluids		AC		CW1		PT
A.3. Is able to analyze project documents of the development process; drawing isobar and development schedule mapping, compare actual and project parameters		AC		CW2		PT
A.4 Is able to estimate resources and reserves			PWR	CW2		PT
A.5 Is able to determine the degree of objects involvement in development and the dynamics of water flooding			PWR	CW3		PT
A.6. Is able to build geological and hydrodynamic models			PWR	CW3		PT
Mastered skills						
S.1 Has mastered the skills in defining the characteristics of reservoirs, fluids, reservoir boundaries and natural mode			PWR			CT
S.2 Has mastered the skills of methodology for well placement and selection of the optimal water flooding type according to the geological and production formation characteristics			PWR			CT
S.3 Has mastered the skills of collecting and systematizing geological and field data for compiling the geological part of development project documents			PWR			CT
S.4 Has mastered the skills of methodology for substantiating the geological and geochemical patterns of oil and gas fields location and their formation issues			PWR			CT
S.5 Has mastered the skills of methodologies for estimating reserves and resources			PWR			CT
S.6 Has mastered the skills of methodologies for geological and hydrodynamic modeling and using it for the field development engineering			PWR			CT

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 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 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 work presentation, practical work presentation and midterm control works (after learning every discipline module).

2.2.1. Presentation of practical work

There are 7 practical jobs 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.

2.2.3. Midterm control work

According to ACWP 3 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 "Properties of hydrocarbon deposits in natural condition and methods for studying reservoirs and fluids", the second CW – on module 2 "Geological foundations of hydrocarbon fields development", the third CW – on modules 3 "Static and dynamic modeling of hydrocarbon deposits as development objects"

Standard tasks of the first CW:

1. The concept of permeability and porosity. Laboratory methods for determining permeability and porosity.
2. Physical properties, oil and gas chemical composition. Methods of deep and surface oil sampling.
3. Reservoir heterogeneity classification.

Standard tasks of the second CW:

1. Reservoir pressure.
2. Water driving mode of the field development.
3. Main technological development parameters.

Standard tasks of the third CW:

1. Types of 3D grids for geological modeling.
2. The concept of aquifer and its types.
3. Black oil model.

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 practical 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 giving 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:

1. The structure of the deposit. Features of terrigenous and carbonate reservoir structure.
2. Layout of fluids in the reservoir. Hydrophilic and hydrophobic reservoir. Oil and gas water saturation of reservoirs.
3. Stages of field development.
4. Parameters to estimate reserves by volumetric method.
5. Reservoir pressure.
6. Setting the initial conditions for hydrodynamic models.

Standard questions and practical tasks for the mastered abilities control:

1. Determine the type of geological heterogeneity.
2. Place wells for development of deposits in natural mode.
3. Build a section of the field.

4. Classify the deposit by the amount of reserves.

5. Calculate the] well's flow rate in given conditions.

6. Systematize the initial information for constructing a geological model.

Standard complex tasks for the acquired skills control:

1. Analyze the main development indicators according to the given oil field development schedule.

2. Analyze the map of the current field operation.

3. Characterize the energy state of the reservoir on the reservoir isobar map.

4. Assess the heterogeneity degree of a geological object based on the field geological profile.

5. Estimate initial oil reserves on the field using the volumetric method.

6. Build a reservoir simulation model.

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 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.