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**Federal State Autonomous Educational Institution of Higher Education
Peoples' Friendship University of Russia named after Patrice Lumumba
RUDN University**

Academy of Engineering

educational division (faculty/institute/academy) as higher education programme developer

COURSE SYLLABUS

**Technologies for developing prospective hydrocarbon reserves / Технологии
разработки перспективных запасов углеводородов**

course title

Recommended by the Didactic Council for the Education Field of:

21.04.01 Oil and Gas Engineering

field of studies / speciality code and title

**The course instruction is implemented within the professional education programme of
higher education:**

Oil and Gas Engineering / Технологии добычи и транспортировки нефти и газа

higher education programme profile/specialisation title

1. COURSE GOAL(s)

The discipline «Technologies for developing prospective hydrocarbon reserves / Технологии разработки перспективных запасов углеводородов» is included in the curriculum of the master's programme "Oil and Gas Engineering / Технологии добычи и транспортировки нефти и газа" within the field of study 21.04.01 "Oil and Gas Engineering" and is studied in the 1-2 semesters of master 1. The discipline is delivered by the Department of Mineral Developing and Oil & Gas Engineering. It consists of 6 sections and 15 topics and is aimed at studying methods of influencing productive oil- and gas-saturated reservoirs in order to control and regulate the filtration of reservoir fluids and increase the degree of hydrocarbon recovery from deposits. As well as acquiring practical skills in solving specific design tasks for calculating oil reservoir development indicators.

The goal of the discipline is to obtain knowledge, skills, abilities and experience in the field of oil field development and operation, acquire critical and systemic thinking when evaluating design solutions for oil field development, as well as master the skill of developing engineering proposals to improve the efficiency of various methods of reservoir stimulation.

2. REQUIREMENTS FOR LEARNING OUTCOMES

The course "Technologies for developing prospective hydrocarbon reserves / Технологии разработки перспективных запасов углеводородов" is designed for students to acquire following competences (competences in part):

Table 2.1. List of competences that students acquire during the course

Competence code	Competence descriptor	Competence formation indicators (within this course)
PC-4	Able to draw up technical documentation for the implementation of the technological process (work schedules, instructions, plans, estimates, requests for materials, equipment, etc.), make an economic assessment of oil and gas fields in accordance with approved forms	PC-4.1. Knows the requirements and GOSTs for the preparation of technical documentation, basic methods of geological and industrial assessment of oil and gas fields; methods of geological-industrial and geological-economic assessment (GEO) of new geological exploration projects, taking into account all the uncertainties and risks of their implementation.
		PC-4.2. Able to prepare and execute technical documentation for the implementation of technological processes in the field of oil and gas field development, transportation and refining of oil and oil products; apply new methods of geological and industrial assessment of oil and gas fields; determine the geological resources and the probability of finding a deposit, its production potential; carry out planning and evaluation of infrastructure solutions; determination of costs for the discovery and development of a field.
		PC-4.3. Has the methodology for preparing primary reporting, including work schedules, instructions, plans, estimates, applications for materials, equipment according to approved forms.

Competence code	Competence descriptor	Competence formation indicators (within this course)
PC-5	Capable of applying the basic principles of rational use of natural resources and environmental protection	PC-5.1. Knows the legal and methodological framework of the procedure for conducting environmental impact assessment EIA and environmental expert activities for use in professional activities; fundamentals of the theory and normative legal acts of the integrated development and rational use of natural resources and environmental protection; the procedure for conducting a geological examination of projects, regulatory documents for compiling an environmental passport.
		PC-5.2. Can assess the state of the environment when conducting complex geological and geographical studies; use mechanisms for the rational use of natural resources and environmental protection; apply regulatory and methodological documents to assess and prevent environmental damage at production facilities.
		PC-5.3. Has the methodology of rational use of natural resources and environmental protection; a system of methods (EIA) and conducting state environmental expertise for successful research and production activities; skills and knowledge to assess environmental damage at production facilities, modern methods for eliminating the consequences and preventing environmental damage at production facilities.
PC-8	Able to organize the work of performers, find and make management decisions, rules for ensuring the safety of technological processes, as well as personnel when working in the field, in laboratories, during office processing	PC-8.1. Knows the safety rules and safety precautions when working in the field, in laboratories, during office processing.
		PC-8.2. Can justify and make management decisions in the field of organization and regulation of labor; conduct briefings on ensuring the safety of technological processes, as well as personnel when working in the field, in laboratories, during office processing.
		PC-8.3. Has the methodology for ensuring the safety of technological processes, as well as personnel when working in the field, in laboratories, during office processing.

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course refers to the variable component of (B1) block of the higher educational programme curriculum.

Table 3.1. The list of the higher education programme components/disciplines that contribute to the achievement of the expected learning outcomes as the course study results

Competence code	Competence descriptor	Previous courses/modules*	Subsequent courses/modules*
PC-4	Able to draw up technical documentation for the implementation of the technological process (work schedules, instructions, plans, estimates, requests for materials, equipment, etc.), make an economic assessment of oil and gas fields in accordance with approved forms		Comprehensive analysis of processing, storage and marketing of hydrocarbons; Diagnostics of oil and petroleum products main pipeline facilities; Improving the efficiency of the production process and operation of equipment for the extraction of hydrocarbons; Innovative technologies for the development of hydrocarbon deposits; Innovative technologies for the transportation and storage of hydrocarbons; Well Repair and Water Breakthrough Control Technologies; Final State Examination
PC-5	Capable of applying the basic principles of rational use of natural resources and environmental protection		Methods for Oil Production Intensification and Enhanced Oil Recovery; Final State Examination
PC-8	Able to organize the work of performers, find and make management decisions, rules for ensuring the safety of technological processes, as well as personnel when working in the field, in laboratories, during office processing		Project management in the oil and gas industry; Economics and management of oil and gas production; Final State Examination

* To be filled in according to the competence matrix of the higher education programme

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the course "Technologies for developing prospective hydrocarbon reserves / Технологии разработки перспективных запасов углеводородов" is 8 credits.

Table 4.1 Types of academic activities during the period of the HE programme mastering

Type of study work	TOTAL, acc.hrs.	Semester(s)	
		1	2
Contact academic hours, acc .	70	36	34
including:	35	18	17
Lectures			

Type of study work	TOTAL, acc.hrs.	Semester(s)	
		1	2
Laboratory work			
Seminars (workshops/tutorials)	52	18	34
<i>Self-study (ies), academic hours</i>	<i>174</i>	<i>108</i>	<i>66</i>
<i>Evaluation and assessment (exam or pass/fail grading)</i>	<i>27</i>	<i></i>	<i>27</i>
The course total workload	acc.hrs.	288	144
	Credits	8	4

5. COURSE CONTENTS

Table 5.1. Course contents and academic activities types

Course module title		Course topic title		Course module contents (topics)	Academic activities types
1	<i>Complicated Conditions for Oil Field Development</i>	1.1	<i>Definition and Examples of Complicated Development Conditions</i>	<i>Defining «complicated conditions»: geological, technological and environmental categories. Real-world field examples: heavy oil, tight reservoirs, deepwater and Arctic developments. Impact of complicated conditions on production performance and economic viability. Risk assessment frameworks for the identification and prioritisation of development challenges.</i>	LC, S
		1.2	<i>Classification of Complicated Conditions and Their Effects</i>	<i>Geological complications: structural complexity, faulting and reservoir heterogeneity. Physical-chemical complications: fluid viscosity, wax/asphaltene deposition and corrosion. Climatic and environmental complications: permafrost, extreme temperatures and remote locations. Technological complications: equipment failure, wellbore integrity issues and scale formation.</i>	LC, S
		1.3	<i>Common Drilling Challenges and Their Consequences</i>	<i>Wellbore instability: causes, detection methods and mitigation measures. Lost circulation and differential sticking: mechanisms and prevention strategies. Non-productive time (NPT) quantification and its impact on drilling economics. Drilling fluid (mud) design and optimisation for challenging formations.</i>	LC, S
2	<i>Complicated Conditions by Nature</i>	2.1	<i>Impact of Geological Factors on Oil and Gas Accumulation</i>	<i>Structural vs. stratigraphic traps: geological controls and drilling implications. Fault zone influence on reservoir connectivity and fluid migration pathways. Rock mechanical properties and their effect on borehole stability. Lithological heterogeneity and its impact on hydrocarbon distribution within the reservoir.</i>	LC, S
		2.2	<i>Influence of Reservoir Fluid Properties on Production</i>	<i>Oil viscosity and API gravity: effect on flow rates, lift system selection and recovery methods. Gas-oil ratio (GOR) behaviour and its management during</i>	LC, S

				<p>production.</p> <p><i>Water-oil emulsion formation: causes, surface treatment requirements and facility impact. Wax and asphaltene deposition: mechanisms, inhibition and chemical treatment strategies.</i></p>	
		2.3	<p><i>Challenges of Arctic and Desert Oil Field Development</i></p>	<p><i>Permafrost drilling: well design, casing schemes and thermal management to prevent thaw subsidence. High-temperature desert environments: equipment heat ratings, fluid requirements and material selection. Logistics and infrastructure challenges in remote and offshore Arctic locations. HSE and environmental regulations governing development in extreme climate zones.</i></p>	LC, S
3	<p><i>Methods for Developing Naturally Complicated Fields</i></p>	3.1	<p><i>Challenges and Solutions for Low-Permeability Reservoirs</i></p>	<p><i>Characterisation of tight and unconventional reservoirs: permeability cutoffs and flow mechanisms. Hydraulic fracturing design: fracture geometry modelling, proppant selection and fluid systems. Horizontal drilling and multi-stage fracturing for tight reservoir development. Economic threshold analysis and development optimisation for tight reservoirs.</i></p>	LC, S
		3.2	<p><i>Development Methods for High-Viscosity Oil Fields</i></p>	<p><i>Thermal EOR methods: steam injection (CSS, steam flooding) and SAGD principles and applications. Chemical EOR for heavy oil: polymer flooding, surfactant injection and ASP processes. Cold heavy oil production with sand (CHOPS): mechanism, applicability and limitations. Comparative evaluation of heavy oil recovery methods: efficiency, costs and reservoir suitability.</i></p>	LC, S
4	<p><i>Complicated Conditions by Technology</i></p>	4.1	<p><i>Effects of Long-Term Production on Oil Fields</i></p>	<p><i>Reservoir pressure depletion mechanisms and their cumulative impact on production rates. Formation damage over time: scale deposition, fines migration and bacterial contamination. Changes in fluid behaviour with pressure decline: evolving GOR, water cut and fluid PVT properties. Surveillance and monitoring strategies for mature field production management.</i></p>	LC, S
		4.2	<p><i>Reservoir Energy Decline and Its Impact on Production</i></p>	<p><i>Natural drive mechanisms: solution gas drive, gas cap drive, water drive and gravity drainage. Drive mechanism depletion and the transition between production stages. Pressure maintenance techniques: water injection, gas injection and WAG design. Material balance approach to reservoir energy assessment and remaining reserve estimation.</i></p>	LC, S
		4.3	<p><i>Water Cut Increase in Mature Fields and Its Causes</i></p>	<p><i>Water coning in vertical wells: mechanism, critical production rate and remediation options. Water breakthrough in horizontal wells and waterflood front management. Zonal heterogeneity and preferential water channelling through high-permeability streaks. Water management strategies: conformance control, water shutoff and produced water</i></p>	LC, S

				reinjection.	
5	<i>Development Methods for Technologically Complicated Fields</i>	5.1	<i>Challenges and Strategies for Late-Stage Oil Field Production</i>	<i>Declining well productivity: diagnosis through well testing, production logging and decline curve analysis. Artificial lift system selection for mature fields: ESP, rod pump and gas lift comparison. Infrastructure ageing: integrity management, workover planning and operational cost optimisation. Field life extension strategies: infill drilling, recompletion and EOR implementation planning.</i>	LC, S
		5.2	<i>Enhanced Oil Recovery (EOR) Technologies and Their Applications</i>	<i>Thermal EOR: steam injection processes (CSS, steam flooding, SAGD) for heavy and medium oil. Chemical EOR: polymer, surfactant and alkaline-surfactant-polymer (ASP) flooding mechanisms. Gas EOR: CO₂ miscible flooding, hydrocarbon gas injection and WAG process design. EOR screening criteria and method selection based on reservoir and fluid characteristics.</i>	LC, S
6	<i>Impact of Complicating Factors on Well Productivity</i>	6.1	<i>Assessing and Managing the Degree of Production Challenges</i>	<i>Pressure transient analysis (PTA): build-up tests, Horner plot and skin factor assessment. Production data analysis: decline curve analysis (DCA) and rate-transient analysis (RTA). Reservoir simulation for diagnosing production challenges and forecasting development scenarios. Integrated asset modelling combining geological, petrophysical and production data.</i>	LC, S
		6.2	<i>Improving the Ultimate Oil Recovery Factor (RF) in Complex Reservoir</i>	<i>Factors controlling recovery factor: drive mechanism, sweep efficiency and displacement efficiency. Artificial lift optimisation: improving ESP, gas lift and PCP system performance in complex reservoirs.</i>	LC, S

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
Lecture	A lecture hall for lecture-type classes, equipped with a set of specialised furniture; board (screen) and technical means of multimedia presentations.	
Seminar	A classroom for conducting seminars, group and individual consultations, current and mid-term assessment; equipped with a set of specialised furniture and technical means for multimedia presentations.	
Computer Lab	A classroom for conducting classes, group and	Virtual Reality Class for Oil

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
	individual consultations, current and mid-term assessment, equipped with personal computers (in the amount of 12 pcs), a board (screen) and technical means of multimedia presentations.	and Gas Production Process Management
Self-studies	A classroom for independent work of students (can be used for seminars and consultations), equipped with a set of specialised furniture and computers with access to the electronic information and educational environment.	

* The premises for students' self-studies are subject to **MANDATORY** mention

7. RESOURCES RECOMMENDED FOR COURSE STUDY

Main readings:

1. Musin, M. M., Lipaev, A. A., Khisamov, R. S. Oil field development / edited by A. A. Lipaev. – 2nd ed., revised and supplemented. – Moscow; Vologda: Infra-Engineering, 2019. – 329 p. : ill., tables, schemes. – ISBN 978-5-9729-0314-6.
2. Galikeev, I. A., Nasyrov, V. A., Nasyrov, A. M. Operation of oil fields in complicated conditions. – Moscow; Vologda: Infra-Engineering, 2019. – 357 p. : ill., tables, schemes. – Access mode: by subscription. – ISBN 978-5-9729-0288-0.
3. Sizov, V. F. Management of the development of oil deposits with hard-to-recover reserves: textbook (lecture course) / Ministry of Education and Science of the Russian Federation, Federal State Autonomous Educational Institution of Higher Professional Education "North Caucasus Federal University". – Stavropol: NCFU, 2014. – 136 p.

Additional(optional) reading (sources):

4. Bulchaev, N. D., Bezborodov, Yu. N. Protection of pumping equipment of oil wells in complicated operating conditions: monograph / Ministry of Education and Science of the Russian Federation, Siberian Federal University. – Krasnoyarsk: Siberian Federal University, 2015. – 138 p. : tables, graphs, ill. – Bibliography in the book. – ISBN 978-5-7638-3263-1.

Internet sources

1. Electronic libraries (EL) of RUDN University and other institutions, to which university students have access on the basis of concluded agreements:
 - RUDN Electronic Library System (RUDN ELS) <http://lib.rudn.ru/MegaPro/Web>
 - EL "University Library Online" <http://www.biblioclub.ru>
 - EL "Yurayt" <http://www.biblio-online.ru>
 - EL "Student Consultant" www.studentlibrary.ru
 - EL "Lan" <http://e.lanbook.com/>
2. Databases and search engines:
 - electronic foundation of legal and normative-technical documentation <http://docs.cntd.ru/>

- Yandex search engine [https:// www .yandex.ru/](https://www.yandex.ru/)
- Google search engine <https://www.google.ru/>
- Scopus abstract database <http://www.elsevierscience.ru/products/scopus/>

Training toolkit for self- studies to master the course *:

1. The set of lectures on the course Technologies for developing prospective hydrocarbon reserves / Технологии разработки перспективных запасов углеводородов.

2. Guidelines for students on the development of the course Technologies for developing prospective hydrocarbon reserves / Технологии разработки перспективных запасов углеводородов.

*The training toolkit and guidelines for the course are placed on the course page in the university telecommunication training and information system under the set procedure.

DEVELOPERS:

Senior lecturer of the Department of Mineral Developing
and Oil&Gas Engineering

Motuzov I.S.

position, department

name and surname

HEAD OF EDUCATIONAL DEPARTMENT:

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**HEAD
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