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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

**Improving the efficiency of the production process and operation of equipment for
the extraction of hydrocarbons / Повышение эффективности процесса добычи и
работы оборудования по добыче углеводородного сырья**

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 «Improving the efficiency of the production process and operation of equipment for the extraction of hydrocarbons / Повышение эффективности процесса добычи и работы оборудования по добыче углеводородного сырья» 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 3rd semester of master 2. The discipline is delivered by the Department of Mineral Developing and Oil & Gas Engineering. It consists of 5 sections and 9 topics and is aimed at studying the methodology for identifying problems in field development and well operation; examining existing intelligent Russian and foreign technologies; acquiring skills in selecting specific equipment; and mastering the methodology for calculating equipment characteristics.

The goal of the course is to provide students with knowledge, skills, competencies, and practical experience in acquiring theoretical knowledge and practical skills for solving complex issues related to the use of software and equipment for well operation and efficient field development; train students to identify problems and select intelligent and technical solutions for the conditions of various fields; provide general knowledge on the application of state-of-the-art technologies and developments in the field of data collection and processing; as well as adjusting and changing operating modes during well operation and field development as a whole.

2. REQUIREMENTS FOR LEARNING OUTCOMES

The course "Improving the efficiency of the production process and operation of equipment for the extraction of hydrocarbons / Повышение эффективности процесса добычи и работы оборудования по добыче углеводородного сырья" 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 | <p>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.</p> <p>PC-4.2. Can draw up and prepare technical documentation for the implementation of technological processes in the field of oil and gas field development, transportation and processing of oil and oil products; apply new methods of geological and industrial evaluation 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.</p> <p>PC-4.3. Has the methodology for preparing primary</p> |

| Competence code | Competence descriptor | Competence formation indicators (within this course) |
|-----------------|---|---|
| | | reporting, including work schedules, instructions, plans, estimates, applications for materials, equipment according to approved forms. |
| PC-6 | Able to organize, manage, and carry out quality control of the main types of work in the development of oil and gas fields, transportation of oil and gas | <p>PC-6.1. Knows: the main types of applied systems for assessing the quality of geological types of work in the development of oil and gas fields, transportation of oil and gas; ISO-9001 quality system, GKZ regulations and classification of oil and gas reserves; requirements of regulatory legal acts of the Russian Federation, local regulations, administrative documents and technical documentation in the field of hydrocarbon production; technological processes of hydrocarbon production; purpose, device and principle of operation of equipment for the extraction of hydrocarbon raw materials; physical and chemical properties of hydrocarbon raw materials, chemical reagents, the procedure and rules for their disposal; technological modes, well operation parameters; standards for technological losses of hydrocarbon raw materials during production in accordance with the accepted scheme and development technology; the influence of various processes occurring in the reservoir on the productivity factor of a production well; the procedure for measuring the productivity factor of a production well; methods for calculating the productivity factor and skin effect according to well surveys with recording the pressure recovery curve; purpose, device and principle of operation of equipment for mechanized production of hydrocarbon raw materials; standards, specifications, guidelines for the development and execution of technical documentation; types of emergencies during well operation, their causes and methods of prevention and elimination; structure, interaction of means of an automated process control system, telemechanics, automatic control systems for hydrocarbon production equipment, ways to control them; requirements for labor protection, industrial, fire and environmental safety.</p> <p>PC-6.2. Can: organize and conduct quality control of work in the development of oil and gas fields, transportation of oil and gas at different stages of the study of specific objects; evaluate the residual life of hydrocarbon production equipment; analyze inflow characteristics in a vertical, horizontal or multilateral well; predict the change in the inflow characteristics from the reservoir to the well, taking into account the reservoir operation mode; develop operating instructions for hydrocarbon production equipment; control the operation of equipment for artificial lift of</p> |

| Competence code | Competence descriptor | Competence formation indicators (within this course) |
|-----------------|-----------------------|--|
| | | hydrocarbons; identify wells operating with deviations from the planned regime; conduct emergency drills with subordinate personnel according to the action plan for localization and elimination of accidents and incidents at hydrocarbon production facilities. PC-6.3. Has: the methodology for assessing the quality of all types of work in the development of oil and gas fields, transportation and processing of oil and gas at different stages of the study of specific objects; skills for organizing and monitoring the implementation of plans and tasks for the extraction of hydrocarbons; skills for operational management of production and monitoring compliance with hydrocarbon production technology; skills for monitoring compliance with the specified operating mode of well equipment, piping, oil and gas field pipelines, prefabricated pipelines, gas pipelines, inhibitor pipelines in accordance with the requirements of the technological regulations of the installation, operating instructions and passports of equipment manufacturers; skills to analyze the dynamics of hydrocarbon production. Organization of providing jobs with up-to-date technological documentation; skills in organizing monitoring and control of the operation of the field and wells; skills of control and management of work on the preparation and maintenance of technical documentation of the unit; skills of control and management in the direction of compliance with the requirements of labor protection, industrial, fire and environmental safety in the unit; skills to control and manage the preparation of reports on the production of hydrocarbons. |

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 | Advanced oil and gas processing equipment and product quality management; Innovative technologies for the development of hydrocarbon deposits; | Pre-graduation Practical Training; State Exam; Graduate Qualification Work |

| Competence code | Competence descriptor | Previous courses/modules* | Subsequent courses/modules* |
|-----------------|---|--|--|
| | materials, equipment, etc.), make an economic assessment of oil and gas fields in accordance with approved forms | Innovative technologies for the transportation and storage of hydrocarbons; Modern aspects of geological and geophysical research in the oil and gas industry; Modern stream in oil and gas processing in Russia; Technologies for developing prospective hydrocarbon reserves; Technological practice (educational); Technological practice (industrial) | |
| PC-6 | Able to organize, manage, and carry out quality control of the main types of work in the development of oil and gas fields, transportation of oil and gas | Current development of the production of unconventional hydrocarbon resources in the world; Innovative technologies for the development of hydrocarbon deposits; Machinery and equipment for field development and transportation of hydrocarbons; Modern aspects of geological and geophysical research in the oil and gas industry; Methods for oil production intensification and enhanced oil recovery | Pre-graduation Practical Training; State Exam; Graduate Qualification Work |

* 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 "Improving the efficiency of the production process and operation of equipment for the extraction of hydrocarbons / Повышение эффективности процесса добычи и работы оборудования по добыче углеводородного сырья" is 5 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) |
|--------------------------------------|-----------------|-------------|
| | | 4 |
| <i>Contact academic hours, acc .</i> | 54 | 54 |
| including: | | |
| Lectures | 16 | 16 |
| Laboratory work | | |

| Type of study work | | TOTAL, acc.hrs. | Semester(s) 4 |
|--|----------|--------------------|-------------------------|
| Seminars (workshops/tutorials) | | 24 | 24 |
| <i>Self-study (ies), academic hours</i> | | <i>113</i> | <i>113</i> |
| <i>Evaluation and assessment (exam or pass/fail grading)</i> | | <i>27</i> | <i>27</i> |
| The course total workload | acc.hrs. | 180 | 180 |
| | Credits | 5 | 5 |

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 Overview of Submersible Pump Equipment | 1.1 Design and main components of ESP. Operating characteristics of a centrifugal pump. | Schematic diagram and main components of an Electric Submersible Pump (ESP) unit. Operating characteristics of a submersible centrifugal pump: head, flow rate, and specific speed of the impeller pump. | LC, S |
| | 1.2 Influence of fluid properties on ESP performance. Complications in ESP operation. | Influence of density and viscosity of the pumped fluid on ESP characteristics. Main complicating factors in well operation with submersible pumps. Prospects for the use of submersible pumping systems. | LC, S |
| 2 Influence of Free Gas and Viscosity on Submersible Centrifugal Pump Performance | 2.1 Hydrodynamics of gas-liquid mixtures (GLM) and experimental studies of gas influence on ESP performance. | Flow patterns of gas-liquid mixtures in the flow passages of centrifugal pump impellers. Parameters affecting the performance of submersible centrifugal pumps when pumping GLM. Design of the experimental setup, selection of model gas-liquid mixtures, and methodology for conducting experiments to study the influence of free gas on submersible centrifugal pump performance. Investigation of gas influence on submersible centrifugal pump performance when operating on model "water-gas" and "water-surfactant-gas" mixtures at different suction pressures. | LC, S |
| | 2.2 ESP operation on viscous GLM and methodology for calculating performance. | Results of studying submersible centrifugal pump operation on viscous "oil-gas" mixtures. Analysis of average integral parameters of submersible centrifugal pumps operating on gas-liquid mixtures. Methodology for calculating submersible centrifugal pump performance when pumping oil-water-gas mixtures from wells. | LC, S |

| | | | | | |
|---|---|-----|--|--|-------|
| 3 | Gas Separation-Free Methods for Improving ESP Efficiency when Pumping Gas-Liquid Mixtures | 3.1 | Gas separation-free methods for managing gas at the ESP suction. | Submerging the pump below the dynamic fluid level in the well. Topping up degassed fluid into the annulus. Use of "tapered" pump configurations. Application of pumps with dispersers. Use of specially designed stages. | LC, S |
| 4 | Application of Gas and Sand Separators with ESPs | 4.1 | Types of gas separators and their field testing. | Main types of gas separators for ESPs. Field testing of MNG separators. The supercavitation effect and its role in the gas separator working process for ESPs. Bench testing and field trials of MN-GSL (pump module with Lyapkov gas separator) and MNG (pump gas separator module) gas separators and separators manufactured by REDA. | LC, S |
| | | 4.2 | Study of gas separators at variable rotation speeds and separation of mechanical impurities. | Experimental studies of the performance characteristics of gas separators and gas separator-dispersers for ESPs at different shaft rotation speeds. Development and field testing of a centrifugal mechanical impurity separator at the inlet of a submersible pumping system. Natural gas production from water-saturated gas wells and methane from coal deposits using submersible pumping systems. | LC, S |
| 5 | Use of Pump-Ejector Systems for Oil Production | 5.1 | Design and joint operation of ESP with an ejector. "Tandem" system. | Schematic diagram and working principle of a jet device. Basic schematics and main components of pump-ejector systems. Performance characteristics of joint operation of submersible centrifugal pumps and ejectors. Results of field testing and industrial implementation of the "Tandem" submersible pump-ejector systems. | LC, S |
| | | 5.2 | Hydraulic jet pumping systems (packer, packerless, with mini-stations). | Field studies of packer hydraulic jet pumping systems at the Samotlor field. Development and field testing of a packerless hydraulic jet pump configuration with a dual-string lift. Development prospects for the hydraulic jet operation method using surface power mini-stations. | 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 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. | Virtual Reality Class for Oil 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. Bolsunovskaya L.M. [and others] Petroleum Engineering. course book = Oil and gas engineering . Book for students: textbook / ed. L.M. Bolsunovskaya, R.N. Abramova, I.A. Matveenko. — Electron . Dan. - Tomsk: TPU, 2014. - 742 p.

<https://e.lanbook.com/book/62912>

2. Tetelmin V.V. Oil and gas engineering . Textbook / V.V. Tetelmin , V.A. Yazev. - 2nd ed ; Dolgoprudny: Publishing House "Intellect", 2014. - 800 p.

<http://lib.rudn.ru>

3. Tetelmin V.V. Oil and Gas Drilling Fundamentals: Study Guide / - 3rd ed. - Dolgoprudny: Intellect, 2014. - 296 p.

<http://znanium.com/catalog/product/478822>

Additional(optional) reading (sources):

1. Saifullin I.Sh., Tetelmin V.V., Yazev V.A. Physical foundations of oil production: Textbook / - Dolgoprudny: Intellect, 2013. - 328 p.

<http://znanium.com/catalog/product/423812>

2. Arbuzov, V.N. Collection of tasks on the technology of oil and gas production in complicated conditions: workshop: study guide / V.N. Arbuzov, E.V. Kurganov. - Electron . Dan. - Tomsk: TPU, 2014. - 68 p.

<https://e.lanbook.com/book/82862>

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 Improving the efficiency of the production process and operation of equipment for the extraction of hydrocarbons / Повышение эффективности процесса добычи и работы оборудования по добыче углеводородного сырья.

2. Guidelines for students on the development of the course Improving the efficiency of the production process and operation of equipment for the extraction of hydrocarbons / Повышение эффективности процесса добычи и работы оборудования по добыче углеводородного сырья.

*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:

Associate Professor of the Department of Mineral
Developing and Oil&Gas Engineering

Tcharo H.

position, department

name and surname

HEAD OF EDUCATIONAL DEPARTMENT:

Mineral Developing and Oil&Gas Engineering

Kotelnikov A.E.

name of department

name and surname

HEAD**OF HIGHER EDUCATION PROGRAMME:**

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Kapustin V.M.

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