Ministry of Science and Higher Education of the Russian Federation

Federal State Budgetary Educational Institution of Higher Education

Perm National Research Polytechnic University

APPROVED BY

Pro-rector for Academic Affairs

_____ N.V. Lobov

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ACADEMIC COURSE WORKING PROGRAM

Academic course: Oil and Gas Chemistry
(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 form a complex of knowledge, abilities and skills for studying oil and gas chemistry.

The objectives of the course are:

- to know the oil formation hypotheses, oil classifications, oil and gas composition, oil and gas physical and chemical properties, methods of oil components extraction and separation;
- to be able to use research methods for the main quality oil and petroleum products indicators, to calculate the physical parameters of oil and gas under various conditions in the process of oil production and transportation;
- to master skills for calculating oil and gas physical and chemical parameters.

1.2. PRESCRIBED OBJECTS OF THE COURSE

Hydrocarbons (oil, natural gas, associated gas and gas condensate); oil, gas and gas condensate physical and chemical properties.

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-3.1.	**IA-1** $_{PC-3.1.}$	**To know** the methods of information analyses concerning the technological processes and operation of technological devices in O&G industry.	**Knows** the oil and other hydrocarbon systems composition; basic physical and chemical methods for studying chemical and fractional composition of oil, petroleum products and gases.	Report on practical work
	IA-2 $_{PC-3.1}$	**To be able to** plan and make necessary experiments including those in which software is applied, interpret the results and draw appropriate conclusions.	**Is able to** calculate the physical parameters of oil and gas under various conditions.	Test

1	2	3	4	5
	IA-3 $_{PC-3.1}$	**To master** the skills to use physical and mathematical tools for computational and analytical tasks solution in the process of professional activity.	**Has mastered** the skills to use methods of qualitative and quantitative analyses of multicomponent systems.	Exam

3. FULL TIME AND FORMS OF ACADEMIC WORK

Academic work form	**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**
1	**2**	**3**	**4**	**5**
Semester 2				
Topic 1 Hypotheses of oil and gas origin. Topic 2. Chemical, technological and economical classification of petroleum. Topic 3. Oil physical properties. Topic 4. Basic gases properties.	6	0	15	9
Topic 5. Groups of hydrocarbon composition: alkanes, naphthenes, aromatics, olefins. Topic 6. Heteroatom petroleum compounds. Topic 7. Petroleum resins and asphaltenes. Topic 8. Composition of oil gases, gas and gas condensate deposits.	4	0	0,5	9

1	2	3	4	5
Topic 9. Oil and petroleum products analytic methods. Topic 10. Chromatographic methods of analysis.	4	0	0,5	7
Topic 11. Oil as a dispersed system. Topic 12. Reservoir waters of oil fields. Topic 13. Oil emulsions.	4	0	2	9
Total with regard to 2nd semester	18	0	18	34
Total with regard to the course	18	0	18	34

Topics of exemplary practical work

Sl. №	Practical (seminar) work topics
1	Methods for expressing the gases component composition: molar, mass, volume fractions, and their mutual recalculation.
2	Physical and chemical calculation of oil properties, petroleum products and gases: density and molecular weight.
3	Practicing in calculating saturated vapor pressure and the boiling point of petroleum products.
4	Graphical methods for calculating the oil and its fractions viscosity at different temperatures. Determination of different oils or fractions viscosity.

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. Basic literature	
1	Organic Chemistry / M.J.S. Dewar [et al.]. – Berlin: Akademie-Verlag, 1985.	1
2	Yen T. F. Environmental Chemistry: Chemistry of Major Environmental Cycles/Teh Fu Yen. – London: Imperial College Press, 2005.	1
	2. Additional literature	
	2.1. Educational and scientific literature	
1	The Chemistry of Nanomaterials: Synthesis, Properties and Applications in 2 Vol. Weinheim : Wiley-VCH Verl., 2007.	1
2	Mikkelsen S. R., Cortón E. Bioanalytical Chemistry. New Jersey : Wiley-Interscience, 2004. XVIII, 361 p.	1
3	Chemistry and Ecology : abstracts for the IX Krai Conference of students and young scientists. Perm, April 24, 2007 / . Perm : Publ. house Perm State Techn. Univ., 2007. 19 p.	3
	2.2. Standardized and Technical literature	
	Not used	
	3. Students' manual in mastering discipline	
	Not used	
	4. Teaching and learning materials for students' homework	
	Not used	

6.2. ELECTRONIC COURSEWARE

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet/ local net; authorized/ free access)
Additional literature	Abstracts for the Regional Conference of Students and Young Scientists "Chemistry. Ecology. Biotechnology – 2015", Perm, April 21-22, 2015 / . Perm : PSTU publ., 2015.	URL: https://elib.pstu.ru/Record/RUPNRPUelib3723	authorized free assess
Additional literature	Abstracts for the Regional Conference of Students and Young Scientists "Chemistry. Ecology. Biotechnology – 2015", Perm, April 21-22, 2015 / . Perm : PSTU publ., 2015.	URL: https://elib.pstu.ru/Record/RUPNRPUelib3723	authorized free assess

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

Type of Software	Software branding
OS	Windows 10 (Azure Dev Tools for Teaching)
Office Applications	Adobe Acrobat Reader DC
Image processing software	Corel CorelDRAW Suite X4
General purpose application software	Mathematica Professional Version (license L3263-7820*)
General purpose application software	Microsoft Office Visio Professional 2016 (Azure Dev Tools for Teaching)
General purpose application software	WinRAR (license №879261.1493674)
Project, research, development, design, modeling and implementation management systems	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/
Lan' Electronic library system	https://e.lanbook.com/
IPR books Electronic library system	http://www.iprbookshop.ru/
Scientific Library of Perm National Research Polytechnic University	http://lib.pstu.ru/
Scientific electronic library Database (eLIBRARY.RU)	https://www.elibrary.ru
Information resources of ConsultantPlus Network	http://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
Lecture	Projector	1

8. FUND OF THE COURSE EVALUATING TOOLS

Described in a separate document

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FUND OF ESTIMATING TOOLS

For students' midterm assessment in the discipline
"Oil and gas chemistry"
Supplement to the Academic Course Working Program

Training program	21.03.01 Oil and gas chemistry
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

Year (-s): 1 **Semester (-s)**: 2

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 "Oil and gas chemistry" 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 second semester of curriculum) and is divided into two educational modules. Classroom activities and lectures as well as students' self-work are provided for each 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 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 composition of oil and other hydrocarbon systems	+	+		+		+
K.2 Knows chemical and physicochemical properties of the main hydrocarbon groups and oil heteroatomic compounds	+	+		+		+
K.3. Knows the oil classification principles and types	+	+		+		+
Acquired abilities						
A.1 Is able to determine gas, oil and petroleum products physical characteristics	+					+
A.2 Is able to calculate the physical parameters of oil and gas under various conditions	+		+			+

1	2	3	4	5	6	7
A.3 Is able to determine the negative effects (corrosion, hydrate formation, AFS deposits, etc.) and methods for their elimination	+					+
Mastered skills						
S.1 Has mastered the skills of multicomponent systems qualitative and quantitative analysis methods	+					+
S.2 Has mastered the skills to perform basic laboratory analyzes to define oil physical and chemical properties	+					+

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 teacher's 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 control works (after learning every discipline module).

2.2.1. 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 "Groups of hydrocarbon composition", the second CW – on module 2 "Basic physical and chemical methods for studying oil, gases, petroleum products and chemical fractional composition".

Standard tasks of the first CW:

1. The concentration of carbon (C) in oil is in the range of ...

a) 60-80 wt. %

b) 80-90 wt. %

c) 30-50 wt. %

d) 10-18 wt. %

e) 0-6 wt. %

2. The fractional composition of the oil product is called ...

a) dependence of density on boiling point

b) the concentration of various hydrocarbon groups in it

c) the dependence of the octane number on temperature

d) the dependence of its boiled-off volume on its density

e) the dependence of its boiling point on the volume of the boiled-off oil product

3. Hydrocarbons of linear structure with the general formula CnH2n + 2 are called ...

a) normal alkanes (n-alkanes, normal paraffins)

b) isoalkanes (isoparaffins)
c) cycloalkanes (naphthenes)
d) arenas (aromatic hydrocarbons)
e) alkenes (unsaturated hydrocarbons, olefins)

4. The formula $\frac{141,5}{\rho_{15}^{15}} - 131,5$ calculates ...

a) ρ_{20}^{20} ρ_{20}^{20}
b) ρ_{4}^{20} ρ_{4}^{20}
c) ρ_{15}^{15} ρ_{15}^{15}
d) API
e) ρ^{t} ρ^{t}

Standard tasks of the second CW:

1. Determination of the sulfur content in oil by combustion in the tube and x-ray fluorescence method.
2. Surface phenomena in the rock-oil-gas-water system.
3. Separation of oil fractions by liquid adsorption chromatography.
4. Classification of petroleum emulsions.

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. FULFILMENT 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. Precondition for admittance is positive integral estimation with respect to the results of continuous assessment and progress check.

2.4.1. Midterm assessment procedure without additional evaluation testing

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

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

2.4.2. Midterm assessment procedure followed by evaluation testing

In definite cases (for example, in case of re-attestation of the discipline) midterm assessment in the form of the test on this discipline can be made as the card-based evaluation test. Every card 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 exam card 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. Modern concepts of oil and gas formation. Elemental composition. Fractional composition. Group hydrocarbon composition. Chemical, technological and economical classification of oils.
2. Synthetic surfactants and their application in the oil industry.
3. Oil physical properties. Density. Molecular mass. Viscosity.
4. Oil physical properties. Saturated vapor pressure. Pour point. Flash point, ignition and self-ignition point.

Standard questions and practical tasks for the mastered abilities control:

1. Methods for determination and isolation of gasoline, kerosene and oil fractions alkanes. Physicochemical and chemical methods for the identification of alkanes. Alkanes as raw materials for chemical processing.
2. Quantification, isolation and identification of alkenes, their influence on the properties of petroleum products. Alkenes as raw materials for chemical processing.

Standard complex tasks for the acquired skills control:

1. Separation with the method of paraffins, naphthenes and aromatic hydrocarbons of various classes gas-liquid chromatography. Isolation of asphaltenes.
2. Adsorbents preparation for the method of gas-liquid chromatography. Study of the adsorbent nature effect on the quality of separated components.

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.