

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

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2021

ACADEMIC COURSE WORKING PROGRAM

Academic course: Geodesy
 (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 (general type, IES)
 (Title of curriculum)

1. GENERAL PROVISIONS

1.1. GOALS AND OBJECTIVES OF THE COURSE

The Goal of the course is to form knowledge about the principles and methods of geodetic measurements, skills to work with geodetic instruments and process measurement results, skills to use ready-made topographic materials to solve practical problems in professional activities.

The Objectives of the course are:

- formation of knowledge about coordinate systems used in geodesy, geodetic networks, geodetic surveys, the principles and methods of geodetic measurements on the surface and geodetic control of the facilities' state in the oil and gas industry;
- working skills formation with geodetic instruments, processing measurement results, performing graphical constructions, carrying out the design elements transfer of structures in nature;
- Working skills formation with ready-made topographic materials and solving the simplest problems of geodesy.

1.2. PRESCRIBED OBJECTS OF THE COURSE

Coordinate systems used in geodesy; geodetic instruments and accessories; measuring angles, distances, and exceedances methods; methods of mathematical processing of measurement results; graphic construction methods; geodetic surveys; graphic documentation (map, plan, profile); methods of geodetic works production at the objects of the oil and gas complex.

1.3. STARTING CONDITIONS

Unstipulated

2. PLANNED RESULTS OF THE COURSE TRAINING

Competence	Indicator's Index	Planned Results of the Course Training (to know, to know how, 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 coordinate systems used in geodesy; general information about geodetic networks and geodetic measurements; methods of geodetic measurements; methods of mathematical processing of measurement	Knows the methods of analyzing information on technological processes and the operation of technical devices in the oil and gas industry	Presentation of laboratory work

1	2	3	4	5
		results; principles and methods of production of geodetic works at the objects of the oil and gas industry.		
PC-3.1	IA-2.PK-3.1	To be able to work with geodetic instruments; to process and interpret measurement results, including with the use of application software products; to choose geodetic control methods of oil and gas industry facilities state	Is able to plan and conduct the necessary experiments, process interpret the results, including with the use of application software products, and draw appropriate conclusions.	Presentation of laboratory work
PC-3.1	IA-3.PC-3.1	To master the skills to use ready-made topographical materials, make plans, maps and profiles based on the results of geodetic measurements, to solve practical problems of geodesy that arise in the course of professional activity	Master the skills to use the physical mathematical apparatus for solving computational analytical problems that arise in the course of professional activity	Presentation of laboratory 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:	56	56
– lectures (L)	18	18
– laboratory work (LW)	36	36
– practice, seminars and/or other seminar-type work (PW)	0	0
– control of self-work (CSW)	2	2
– test		
1.2. Students' self-work (SSW)	52	52
2. Intermediate attestation		
Exam		
Grading test		
Test (Credit)	9	9
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
6 semester				
Unit 1 Objects of geodetic measurements	5	8	0	15
<p>Topic 1 Subject and tasks of geodesy Subject, tasks and methods of geodesy. Brief information from the history of geodesy. Connection of geodesy with other sciences. Units of measurement used in geodesy.</p> <p>Topic 2. The shape and size of the Earth. Coordinate Systems. General information about coordinate systems. Coordinate systems used in engineering geodesy: geodesic, zonal rectangular, local. Height system.</p> <p>Topic 3. Orientation True and magnetic azimuths. Directional angles and the connection between them. Declination of the magnetic needle. Convergence of the meridians. Direct and inverse geodesic problem.</p> <p>Topic 4. Plan and map Scales, their types, and the accuracy of the scale. Content of plans and maps. The situation. Terrain. Ways to depict the situation and terrain on plans and maps. Problems to be solved on plans and maps.</p>				
Unit 2 The accuracy evaluation of geodetic measurements	1	2	0	5
<p>Topic 5. The theory of errors basics. Errors, their types; properties of random errors. The average square error. Maximum margin of error. Residuals.</p>				
Unit 3 Geodetic works on the earth's surface	10	22	0	27
<p>Topic 6. Geodetic networks Geodetic measurements classification. Organization of geodetic works rules; principles of geodetic works making. Geodetic networks. geodetic networks classification, its purpose, design principles. Methods for constructing planned geodetic networks. State geodetic network, geodesic network of condensation, survey network. Methods for building high-rise networks. Geodetic signs and centers. Topic 7. Geodetic instruments Theodolites. Classification. Purpose Device and verification of theodolites. Methods for measuring horizontal and vertical angles. Levelers. Classification. Purpose The device. Levelling rails. Methods for measuring excess values.</p> <p>Topic 8. Theodolite passage The purpose of the theodolite passage. Field cycle: reconnoitering, fixing the course points, characterization of the traverse geometry, linking the traverse to the points</p>				

1	2	3	4	5
of the reference geodetic network, measurements in theodolite passage. Measurement accuracy and control. Theodolite survey. Situation survey. Desk work: calculations and graphical constructions. Topic 9. High-altitude surveys Types of leveling. Methods of geometric leveling. Longitudinal leveling. The concept of the trace. Field tracing cycle: reconnoitering, splitting the trace and curves, fixing pickets. Picket magazine. The order of operation at the station with geometric leveling. Measurement accuracy and control. Desk work: calculations, graphic constructions, design. Trigonometric leveling. Its concept. Basic formulas. Topic 10. Topographic surveys. Types of topographic surveys. Total station survey. Its concept. Field cycle of total station survey: reconnaissance, creation of a planned altitude justification, survey of the situation and terrain. Desk work: calculations and graphical constructions.				
Unit 4. Geodetic maintenance of oil and gas industry facilities	2	4	0	5
Topic 11. Principles and methods of geodetic works production at the oil and gas industry facilities. Preparation of geodetic data for making the project in nature. Methods of rendering the project in nature. Drawing a horizontal angle, distance, mark, line with a given slope on the terrain. The main types of geodetic works and methods of geodetic control at the oil and gas industry facilities.				
Total with regard to semester	18	36	0	52
Total with regard to the course	18	36	0	52

Topics of exemplary practical work

Sl.No	Topic of practical (seminar) work
1	Unstipulated

Topics of exemplary laboratory practice

Sl.No	Topic of laboratory work
1	Working with the map
2	Nomenclature
3	Terrain exploration
4	Theodolite device and angle measurement
5	Calculating the coordinates of the points of the theodolite traverse and building a contour plan
6	Levelling device and excess measurement
7	Log processing geometric leveling and building a longitudinal profile
8	Processing of the total station survey log and building a topographic plan
9	Preparation of geodetic data for making the project in nature.

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.

Laboratory classes are based on an interactive learning method in which students communicate not only with the teacher but also with each other. At the same time, students' activity in the learning process dominates. The teacher's place in interactive classes is reduced to orienting students' activities to achievement of the goals of studies.

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 students are recommended to fulfill the following positions:

1. Learning of the discipline should be done systematically.
2. After learning one of the course unit with the help of the text-book or lecture notes it is recommended to reproduce in memory the basic terms, definitions, notions of the unit.
3. Special attention should be paid to the reports on practical studies, laboratory works and individual complex tasks for self-work.
4. The topic of questions studied individually is given by the teacher at the lectures. Also the teacher refers to the literary resources (first of all, to the newly published in periodicals) in order the students understand the problems touched on the lectures in detail.

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	Gravimetry and Geodesy / Brover V. and all. M., 2010. 570 p.	1
2. Additional literature		
2.1. Educational and scientific literature		
1	Studia Geophysica et Geodaetica Vol. 51, 1 a journal of geophysics, meteorology and climatology, geodesy Praha : StudiaGeo s.r.o., 2007	1
2	Proceedings of International Symposium Terrestrial Gravimetry: Static and Mobile Measurements, Saint Petersburg, 20-23 August 2007 / . Saint Petersburg : Elektropribor, 2008. 283 p.	1

6.2. ELECTRONIC COURSEWARE

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet/local net; authorized free assess)
Additional literature	Studia Geophysica et Geodaetica Vol. 51, 2 a journal of geophysics, meteorology and climatology, geodesy Praha : StudiaGeo s.r.o., 2007	URL: https://elib.pstu.ru/vufind/Record/RUPSTUser95849	authorized free assess
Additional literature	Proceedings of International Symposium Terrestrial Gravimetry: Static and Mobile Measurements, Saint Petersburg, 20-23 August 2007 / Saint Petersburg : Elektropribor, 2008. 283 p.	URL: https://elib.pstu.ru/vufind/Record/RUPSTUbooks128604	authorized free assess

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

Type of Software	Software branding
Operating systems	Windows 10 (subp. Azure Dev Tools for Teaching)
Office applications.	Adobe Acrobat Reader DC. free pdf viewer software
Office applications.	Microsoft Office Professional 2007. – 42661567
General-purpose application software	Dr. Web Enterprise Security Suite, 3000 persons, PNRPU OCNIT 2017

6.4. MODERN PROFESSIONAL DATABASES AND INQUIRY SYSTEMS USED IN THE COURSE EDUCATIONAL PROCESS

Branding	Reference to information resource
Scientific Library of the Perm National Research Polytechnic University	http://lib.pstu.ru/
Lan' Electronic Library System	https://edanbook.com/
Electronic library system IPRbooks	http://www.iprbookshop.ru/
Informational resources of the ConsultantPlus Network	http://www.consultant.ru/

7. LOGISTICS OF THE COURSE EDUCATIONAL PROCESS

Type of classes	Name of the necessary basic equipment	Number of units
Laboratory work	Level 3N-5L	14
Laboratory work	Plumb line	22
Laboratory work	Stand	11
Laboratory work	Levelling rail	20
Laboratory work	Roulette 30 m	10
Laboratory work	Theodolite 4T30P	14
Laboratory work	Tripod	15
Lecture	A laptop	1
Lecture	Projector	1
Lecture	Wall-mounted screen	1
Practical lesson	not provided	1

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
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FUND OF ESTIMATING TOOLS

**For students' midterm assessment in the discipline
 Geodesy**

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): 3	Semester (-s): 6

Workload

in credits 3 CU

in hours 108 h

The form of midterm assessment:

Test: 6 semester

Fund of estimating tools for midterm assessment of students' learning the subject Geodesy 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.

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 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 Geodesy (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. 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	T/CW	CT	Test
1	2	3	4	5	6	7
Acquired knowledge						
K.1 Knows the coordinate systems used in geodesy	D	AC1		CW1		TQ
K.2 Knows the general information about geodetic networks and geodetic measurements	D	AC1		CW1		TQ
K.3 Knows the methods of geodetic measurements		AC2		CW2		TQ
K.4 Knows the methods of mathematical processing of measurement results.		AC2		CW2		TQ
K.5 Knows the principles and methods of production of geodetic works at the objects of the oil and gas industry		AC3		CW3		TQ
Acquired abilities						
A.1 Is able to work with geodetic instrument			LWR4 LWR6	CW2		PT
A.2 Is able to process and interpret measurement results, including with the use of application software products			LWR5 LWR7 LWR8	CW2		PT
A.3 Is able to choose geodetic control methods of oil and gas industry facilities state			LWR9	CW3		PT

1	2	3	4	5	6	7
Mastered skills						
S.1 Masters the skills to use ready-made topographical materials, make plans, maps and profiles based on the results of geodetic measurements, to solve practical problems of geodesy that arise in the course of professional activity			LWR1 LWR2 LWR3 LWR9			PT

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 grading test taking into consideration the results of the continuous assessment 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 laboratory work presentation and midterm control works (after learning every discipline module). 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.

2.2.1. Presentation of laboratory work

It is planned 9 laboratory works all in all. Standard topics of laboratory work are given in ACWP.

Presentation of laboratory work is made by the student individually. 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 3 midterm control works (CW) is planned to be realized after learning the educational modules of the discipline by the students. The first CW is realized with respect to the module 1 Basis of the geodesy, which includes Section 1 and 2, the second CW – with respect to the module 2 Geodetic works on the earth's surface, which includes Section 3, the third CW – with respect to the module 3 Special part, which includes Section 4.

Standard tasks of the first CW:

1. Information about the figure and size of the Earth.
2. Coordinate systems used in geodesy.
3. Directional angle and rhumb.
4. True and magnetic azimuths.
5. Plan and map.
6. Terrain, types of terrain, horizontal.
7. Scales, types of scales.
8. Nomenclature of the topographic maps.

Standard tasks of the second CW:

1. Geodetic networks and their types.
2. Angle and linear measurement.

3. Measurement of excess values.
4. Theodolite survey.
5. Leveling.
6. Topographic survey.

Standard tasks of the third CW:

1. Preparation of geodetic data for making the project in nature
2. Drawing a horizontal angle, distance, and mark on the terrain.
3. Geodetic works production at the objects of the oil and gas complex.

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 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. Test 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 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. Concept about the shape and the size of the Earth.
2. Coordinate systems, used for plan and map construction.
3. Topographic maps and plans.
4. Concepts of theodolite survey, types of theodolite passage, the order of the field work, measurement accuracy.
5. Governmental leveling network. Height system.
6. Concepts of total station survey. Merits and demerits.
7. Orientation of lines. Orienting angles.
8. Terrain and its shapes.
9. Tasks and types of leveling.
10. Excess measurement.
11. Trigonometric leveling. Its concept.
12. The geodetic network reference.
13. Geodetic works at the objects of the oil and gas complex.

Standard questions and practical tasks for the mastered abilities control:

1. Determinate coordinates of the points and orienting angles of the line on the map.
2. Determinate nomenclature of the map.
3. Determinate horizontally height of point, slope gradient.
4. Examine the theodolite device.
5. Calculate the coordinates of the points of the closed theodolite traverse.
6. Examine the leveler device.
7. Calculate the list of leveling; calculate curve data and stationing value.
8. Processing of the total station survey log and building a topographic plan.

Standard complex tasks for the acquired skills control:

1. Solve direct and inverse geodesic problems.
2. Get theodolite into working position. Measure horizontal and vertical angles.
3. Get leveler into working position and measure excess values.
4. Build a plan of the theodolite passage.
5. Build a longitudinal profile and a curve.
6. Calculate the geodetic data for making the project in nature.

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* 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.