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: Physics, special chapters
(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): B1.CV.02.2
(Code and denomination of degree)

Direction: Oil and Gas Engineering
(Title of curriculum)

Perm 2021

1. GENERAL PROVISIONS

1.1. GOALS AND OBJECTIVES OF THE COURSE

The goal of the course is:

• to study physical phenomena and the laws of physics, the limits of their application, practical application of laws; to get acquainted with the basic physical quantities, to know their definition, meaning, methods and units of their measurement; to carry out fundamental physical experiments and to understand their role in the science development; to know the purpose and principles of physical devices operation;

• to develop skills of working with modern physical instruments and equipment; skills of using various methods of physical measurement and processing the experimental data; skills of physical and mathematical modeling, skills of physical and mathematical analysis to solve scientific and technical problems;

• to understand the logical connection between the course parts, to develop the knowledge of physics as a universal basis for the technical sciences, to promote the idea that physical phenomena and processes limitedly applied in technology may in the future be at the center of innovative engineering achievements.

As a result of studying the discipline the student

knows:

– basic physical phenomena and processes which the principles of objects action are based on, areas and possibilities of using physical effects;

– fundamental concepts, laws and theories of classical and modern physics, the limits of basic physical models application;

– basic physical quantities and constants, their definitions and units of measurement;

– methods of physical research, including methods of physical modeling processes;

– methods of solving physical problems significant for technical application;

– physical foundation of measurements, methods of measuring physical quantities;

– technologies for working with various types of data;

is be able to:

– allocate physical content in systems and devices of different physical nature;

– carry out a correct mathematical description of physical phenomena in technological processes;

– build and analyze mathematical models of physical phenomena and processes solving applied problems;

– solve typical problems in the main sections of physics, using the methods of mathematical analysis and modeling;

– apply concepts, physical laws and methods of technical calculations, analyzing and solving practical problems, conducting research in professional activities;

– use modern physical equipment and devices in solving practical problems, to use the basic techniques for evaluating the error and processing experimental data;

has mastered the skills of:

– analysis methods of physical phenomena in technical devices and systems;

– skills in practical application of physical laws, including the products and processes design;

– theoretical research methods of physical phenomena and processes, construction of mathematical and physical models of real systems, solving physical problems;

– using basic physical devices;

– experimental physical research methods (planning, installation and processing of experimental data, including standard software packages);

– applying knowledge in physics to study other disciplines.

1.2. STUDIED OBJECTS OF THE COURSE

Physical phenomena and processes in natural and human-made systems;

• Physical laws describing the phenomena and processes;

• Instruments for studying physical systems;

• Methods of physical systems research;

• Methods of physical systems formalized description, including mathematical and computer modeling.

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
GPC-1	$IA\text{-}1_{gpc\text{-}1}$	To know the mathematical formalization of fundamental physical laws in homogeneous and inhomogeneous media, including the laws of heat conduction, diffusion, fluid dynamics, filtration of liquids and gas.	Knows the ways to solve problems related to professional activities, applying methods of modeling, mathematical analysis, natural science and general engineering knowledge.	Interview

1	2	3	4	5
GPC-1	**IA-2$_{gpc-1.}$**	To be able to formulate and solve applied physical problems in the study of physical processes in mining.	**Is able to** solve problems related to professional activities, applying methods of modeling and mathematical analysis, to natural science and general engineering knowledge.	Individual task
GPC-1	**IA-3$_{gpc-1.}$**	To master the skills of applying physical methods for solving problems in the study of physical processes in mining.	**Has mastered** the skills of solving problems related to professional activities, applying methods of modeling and mathematical analysis, to natural science and general engineering knowledge.	Test
GPC-4.	**IA-1$_{gpc-4.}$**	To know the ways of processing and presenting the results of solving applied physical problems.	**Knows** how to make measurements and observations, process and present the experimental data.	Interview
GPC-4.	**IA-2$_{gpc-4.}$**	To be able to analyze and present the results of solving applied physical problems.	**Is able to** measure and observe, process and present the experimental data.	Individual task
GPC-4.	**IA-3$_{gpc-4.}$**	To master physical methods for solving applied problems in the study of physical processes in mining.	**Has mastered** the skills of making measurements and observations, processing and presenting the experimental data.	Test
GPC-7.	**IA-1$_{gpc-7.}$**	To know the main methods of solving applied problems in extraction, processing of minerals and the construction of underground structures.	**Knows** how to analyze, compile and apply technical documentation related to professional activities according to the applicable regulatory acts.	Interview
GPC-7.	**IA-2$_{gpc-7.}$**	To be able to analyze and formalize condition tasks.	**Is able to** analyze, compile and apply technical documentation related to professional activities according to the applicable regulatory acts.	Individual Task
GPC-7.	**IA-3$_{gpc-7.}$**	To master the skills of analyzing the physical problem and presenting its solution according to the norms of technical documentation.	**Has mastered** the skills of analyzing, composing and applying the technical documentation related to professional activities according to the applicable regulatory acts.	Test

3. FULL TIME AND FORMS OF ACADEMIC WORK

Form of academic work	Hours in all	Distribution in hours according to semesters
		Number of semesters
		7
1. Holding classes (including results monitoring) in the form: 1.1.Contact classwork, including:	45	45
– lectures (L)	16	16
– laboratory work (LW)		
– practice, seminars and/or other seminar-type work (PW)	27	27
– control of self-work (CSW)	2	2
– test		
1.2. Students' self-work (SSW)	63	63
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
Semester 7				
Equations of mathematical physics	8	0	13	32
The main equations types of mathematical physics: parabolic, hyperbolic and elliptic types. Formulation of the problem. Non-stationary heat conduction processes. Cooling (heating) unlimited plate. Variable separation method – Fourier method. Simplification of the solution. Dimensionless form. Analysis of the solution. The amount of heat given off by the plate at cooling. Lagrange interpolation polynomials. Stationary thermal conductivity. Heat transfer through a flat wall. Boundary conditions of the first kind, the third kind. Stationary thermal conductivity in a ball, taking into account internal heat sources. Derivation of the heat conduction equation for the spherically symmetric case. Calculation of the temperature field. Thermal conductivity in a bar (rib) of constant cross-section. Rod of infinite and finite length. Hyperbolic functions. Cooling (heating) bodies of finite dimensions. Solution multiplication theorem. Wave equation. Transverse vibrations of a string fixed at the				

1	2	3	4	5
ends. Fourier method. Fourier expansion of functions. Fourier integral. Problems leading to the Laplace's equation. Laplace's equation in cylindrical coordinates. Integral Laplace transform. Table of originals and images. Solution of differential equations using operational calculus. Method of indefinite coefficients. Free damped and undamped oscillations. Solutions using the Laplace transform. Forced vibrations. Solution using the Laplace transform. Oscillatory circuit (C, L, R). Solution for the charge dependence on the capacitor and the current strength on time. Approximate solution of a differential equation using the Taylor and Maclaurin series.				
Mechanics and thermodynamics of liquids and gas.	8	0	14	31
Equations of incompressible viscous fluid motion. Some exact solutions of the viscous incompressible fluid motion equations. The steady fluid motion between parallel planes in the Couette flow. Velocity profile and flow rate. The fluid movement in a round tube in Poiseuille flow. Parabolic velocity profile. Volumetric flow rate and average velocity. Reynolds number. Hydrodynamic stabilization section. Hydraulic radius for pipes with complex cross-sectional profiles. Free convection equations in the Boussinesq approximation. Convective flow in a vertical layer. Problem statement and solution. Hyperbolic functions. Change in entropy while measuring the body temperature with a thermometer. Bodies fall of variable mass. Evenly evaporating drop of water. Stokes resistance force. Bullet movement inside the substance. Ball in liquid. Determination of the pressure force on the lower half of the ball's surface. Equation derivation of state for an ideal gas with the proportionality of heat capacity to temperature.				
Total with regard to 7th semester	16	0	27	63
Total with regard to the Course	16	0	27	63

Topics of exemplary practical work

Sl. №	The topics of practical (seminar) work
1	The problem of cooling a plate. Temperature distribution and heat loss. Lagrange interpolation polynomials.
2	Stationary thermal conductivity in a ball with internal heat sources. Thermal conductivity in a bar (rib) of constant cross-section. Rod of infinite and finite length. Hyperbolic functions.
3	Cooling (heating) bodies of finite dimensions. Example of a parallelepiped.
4	Free damped and undamped oscillations. Solutions using the Laplace transform.
5	Forced vibrations. Solution using Laplace transform.
6	An approximate solution of a differential equation using the Taylor and Maclaurin series.
7	The bodies fall of variable mass. Evenly evaporating drop of water. Stokes resistance force. Finding the movement speed dependence on time.
8	Ball in liquid. Determination of the pressure force on the lower half of the ball surface.

Sl. №	The topics of practical (seminar) work
9	Sliding a bar over a rough surface. Braking time in case of partial and complete collision on a rough area. Examples for different values of the friction coefficient.
10	Equation derivation of state for an ideal gas with the proportionality of the heat capacity to temperature.
11	Change calculation in the internal energy of the nitrogen mass during quasi-static adiabatic expansion from the volume V1 at normal pressure p1 to the volume V2.
12	Study of measuring the thermophysical characteristics of solids by the quasi-linear method.
13	Study of an explicit scheme for calculating temperature fields. Sequential relaxation method. Isothermal boundaries
14	Study of an implicit scheme for calculating temperature fields. Longitudinal-transverse sweep method. Nonstationary boundary conditions

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	Henner V. Mathematical Methods in Physics. Partial Differential Equations, Fourier Series, and Special Functions / V. Henner, T. Belozerova, K. Forinash. – Wellesley. Massachusetts: A K Peters. Ltd, 2009.	1
2	Busch G. Lectures on Solid State Physics : Transl. from Germ. / G. Busch, H. Schade. – Oxford: Pergamon Press, 1976.	1
	2. Additional literature	
	2.1. Educational and scientific literature	
3	In the world of science = Scientific American: scientific-inform. journal / In the world of science. – M.: In the world of science. 2004-2009. – Monthly	
4	Skibicki W. Slownik Terminow Fizycznych. Glossary of Physics. Dictionnaire de Physique. Physikalisches Wörterbuch. Dictionary of Physics: Polsko-Angielsko-Francusko-Niemiecko-Rosyjski / W. Skibicki. – Warszawa: Panstwowe Wydawnictwo Naukowe, 1961.	1
5	Physics-Uspekhi (Advances in Physical Sciences) 1993-present Physics-Uspekhi Online ISSN: 1468-4780 Print ISSN: 1063-7869	
	2.2. Standardized and Technical literature	
6	Sachs G. Practical Metallurgy. Applied Physical Metallurgy and the Industrial Processing of Ferrous and Nonferrous Metals and Alloys / G. Sachs, K. R. V. Horn. – Cleveland: American Society for Metals, 1940.	1
	3. Students' manual in mastering discipline	
7	Fundamentals of Physics. Author, I.E. Irodov. Publisher, CBS Publishers & Distributors, 2005. ISBN, 8123903022, 9788123903026. Length, 455 pages.	
8	I.E Irodov's "Problems in General Physics" Arihant Publication; 6th edition (January 1, 2016)	
	4. Teaching and learning materials for students' self-work	
9	Electronic library of the Scientific Library of Perm National Research Polytechnic University [Electronic resource]: [full-text database electron. documents published in the PNRPU Publishing House]. – Electron. Dan. (1912 entries) – Perm, 2014-2015. – Access mode: http://elib.pstu.ru/. – Title from the screen.	
10	American Physical Society Journals [Electronic resource]: [full-text database: electron. zhurn. in physics in English language] / American Physical Society (APS). – New York, 2015. – Available at: http://www.journals.aps.org. – Title from the screen.	

6.2. ELECTRONIC COURSEWARE

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet/local net; authorized free access)
Presentations	Physic's Lectures		authorized free access

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	Microsoft Office Professional 2007. lic. 42661567 Adobe Acrobat Reader DC
General-purpose application software	Dr. Web Enterprise Security Suite, 3000 license PNRPU OCNIT 2017
Image processing software	Corel CorelDRAW Suite X4
General purpose application software	Mathematical 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

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

Branding	Reference to information resource
Scientific Library of Perm National Research Polytechnic University	http://lib.pstu.ru/
Lan' electronic library system	https://e.lanbook.com/
Electronic library system IPRbooks	http://www.iprbookshop.ru/
Information resources of the ConsultantPlus Network	http://www.consultant.ru/
Scopus database	https://www.scopus.com/
Web of Science Database	https://www.webofscience.com/
Scientific electronic library database (eLIBRARY.RU)	https://elibrary.ru/
Company database EBSCO	https://www.ebsco.com/

7. LOGISTICS OF THE COURSE EDUCATIONAL PROCESS

Type of classes	Name of the necessary basic equipment	Number of units
Laboratory class	Stand "Determination of the cylinder volume"	12
	Stand "Determination of free fall acceleration using the Atwood machine"	1
	Stand "Research of balls' collisions"	1
	Stand "Oberbek's Pendulum"	12

Type of classes	Name of the necessary basic equipment	Number of units
	Stand "Determination of the bullet's speed by the ballistic pendulum method"	1
	Stand "Study of the gyroscope precession"	1
	Stand "Maxwell's Pendulum"	1
	Stand "Physical pendulum"	10
	Stand "Determination of free fall acceleration by the method of revolving physical pendulum"	8
	Stand "Determination of the bodies inertia moment by the method of torsional vibrations"	2
	Stand "Study of free spring pendulum vibrations"	10
	Stand "Determination of the rolling friction coefficient by the inclined pendulum method"	1
	Stand "Determination of liquid viscosity by Stokes method"	10
	Stand "Determination of the adiabatic index for air"	4
	Stand "Measurement of the liquid viscosity coefficient and determination of the activation energy"	1
	Stand "Research of the surface tension water coefficient dependence on temperature"	1
	Stand "Measurement of the linear expansion temperature coefficient"	1
Laboratory class	Stand "Study of an electronic oscilloscope"	6
	Stand "Study of electrostatic fields"	10
	Stand "Determination of emf current source by the compensation method"	6
	Stand "Thermocouple calibration"	6
	Stand "Determination of magnetic induction in the device pole gap of the magnetoelectric system"	8
	Stand "Research of the circular current magnetic field"	4
	Stand "Determination of the Earth's magnetic field induction using a cathode-ray tube"	6
	Stand "Study of the electromagnetic induction and mutual induction phenomenon"	1
	Stand "Study of the electronic oscilloscope hysteresis phenomenon"	4
	Stand "Investigation of the magnets dynamic susceptibility"	1
	Stand "Study of damped oscillations in a circuit"	4
	Stand "Study of forced vibrations in a sequential circuit"	1
Laboratory class	Stand "Determination of the solids refractive index using a microscope"	6
	Stand "Determination of the lenses focal length"	6
	Stand "Determination of the Newton's lens curvature radius"	6
	Stand "Determination of the light wavelength using Newton's rings "	6
	Stand "Fresnel Biprism"	4
	Stand "Interference of laser light in a thick plate"	2
	Stand "Determination of the light wavelength using diffraction grating"	6
	Stand "Study of the light diffraction phenomenon by diffraction grating"	6

Type of classes	Name of the necessary basic equipment	Number of units
Laboratory class	Stand "Determining the distance between gaps in Jung's experiment"	6
	Stand "Diffraction by a slit, systems of slits, one-dimensional and two-dimensional diffraction gratings"	6
	Stand "Determination of the sugar solution concentration with a polarimeter"	2
	Stand "Determination of the laser beam polarization degree. Study of Malus' and Brewster's Laws"	6
	Stand "Receiving and studying elliptically polarized light"	6
	Stand "Measurement of the liquid refractive index using the Rayleigh interferometer"	1
	Stand "Determination of surface roughness using the Linnik microinterferometer"	1
	Stand "Measurement of the body temperature and integral emissivity by the spectral relations method"	6
	Stand "Study of the LED emission spectrum"	2
	Stand "Photocell research"	4
	Stand "External photo effect. Planck constant"	2
	Stand "Spectral characteristics of photoconductivity"	2
	Stand "Determination of the Stefan-Boltzmann constant using the disappearing filament pyrometer"	1
	Stand "Determination of the Planck constant using a LED"	4
	Stand "Investigation of line emission spectra using the UM-3 monochromator"	2
	Stand "Study of the substance light absorption dependence on the light wave length"	2
	Stand "Investigation of semiconductors electrical characteristics using the Hall effect"	1
	Stand "Study of semiconductors electrical resistance dependence on temperature"	1
	Stand "Study of the metals electrical resistance dependence on temperature"	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
Perm National Research Polytechnic University

FUND OF ESTIMATING TOOLS

For students' midterm assessment in the discipline
"Physics, special chapters"
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): 4 **Semester(s)**: 7

Workload:
in credits 3
in hours 108

The form of midterm assessment:
Test 7 semester

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Fund of estimating tools for midterm assessment of students' learning the subject "Physics" 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 three semesters (the first three semesters of curriculum) and is divided into eight 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 "Physics" (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 basic physical phenomena and basic laws of physics, the limits of their applicability, the possibility of using them in practical applications;	+	+		CW1-2		TQ
K.2 Knows basic physical quantities and physical constants, their definition, meaning, units of their measurement;	+	+		CW1-2		TQ
K.3. Knows basic methods of physical research, including fundamental physical experiments and their role in the development of the science;	+	+		CW1-2		TQ
K.4. Knows the purpose and principle of most important physical devices and objects, measuring and control instruments operation;	+	+				TQ

1	2	3	4	5	6	7
K.5. Knows methods of solving physical problems corresponding to professional activity;	+	+		CW1-2		TQ
K.6. Knows basic techniques and technologies for working with various types of information.	+	+		CW1-2		TQ
Acquired abilities						
A.1 Is able to analyze and explain natural phenomena and man-made effects of fundamental physical concepts;						PT
A.2 Is able to indicate the laws to describe a given phenomenon or effect, to highlight physical content in applied problems, to search for and organize relevant information;				CW1-2		PT
A.3. Is able to interpret the meaning of physical quantities and concepts;				CW1-2		PT
A.4. Is able to write down equations for physical quantities in the SI system;				CW1-2		PT
A.5. Is able to use the basic concepts, laws and models of physics, to operate them to solve applied problems;				CW1-2		PT
A.6. Is able to work with instruments and equipment, to use various measurement techniques for experimental data processing and interpretation;						PT
A.7. Is able to apply physical and mathematical analysis methods to solve applied problems, to use adequate methods of physical and mathematical modeling and calculation using software.				CW1-2		PT
Mastered skills						
S.1 Has mastered the skills of using basic physical laws and principles in the most important practical applications, methods of solving typical problems;				CW1-2		CT
S.2 Has mastered the skills in applying the basic methods of physical and mathematical analysis and mathematical formalization for solving applied problems and searching for necessary information;				CW1-2		CT
S.3 Has mastered the skills of applying the main instruments and equipment in a modern laboratory;						
S.4 Has mastered the skills of conducting a scientific and technical experiment, processing, analyzing and interpreting its results;						CT
S.5 Has mastered the skills of using physical and mathematical modeling methods in engineering practice, analysis and interpretation of its results using applied software;				CW1-2		CT
S.6 Has mastered the skills of searching for, selection, systematization, analysis and generalization of scientific and technical data, its				CW1-2		CT

1	2	3	4	5	6	7
interpretation and presentation in the form of texts, tables, graphs and diagrams;						
S.7 Has mastered the skills of self-study and development in general cultural and professional spheres.						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 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 colloquium, theoretical question and midterm 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.

Module 1. Equations of mathematical physics.

Module 2. Oscillations and Waves.

Midterm examinations can be replaced by computerized tests of equivalent content.

Standard tasks of the first CW:

Topic "Equations of mathematical physics":

1. Write the main equations types of mathematical physics: parabolic, hyperbolic and elliptic types. How to formulate a problem (equation, initial conditions or boundary conditions)? Give an example.
2. Describe non-stationary heat conduction processes.
3. Thermal conductivity equation. Solving the homogeneous equation of thermal conductivity by the Fourier method.
4. Heat equation for the stationary case.
5. Dirichlet problem for a circle.

Standard tasks of the second CW:

Topic "Oscillations and Waves":

1. Write the equations of viscous incompressible fluid motion. Give an example of viscous incompressible fluid motion.
2. Discuss some exact solutions of viscous incompressible fluid motion equations.
3. Discuss the steady fluid motion between parallel planes in the Couette flow.
4. Solution to the equation of free fixed string vibrations at the ends by the method of variables separation.

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. 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 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. Laplace's equation in cylindrical coordinates.
2. Fourier method. Fourier expansion of functions. Fourier integral.
3. Method of indefinite coefficients.

Standard questions and practical tasks for the mastered abilities control:

1. Two physical processes are described by the equations $\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}$ and $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, respectively. In which are the both directions of the time course equal? How does it affect the formulation of the Cauchy problem for each equation?

2. Find the solution to the equation $\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2}$, satisfying the conditions: $u(0,t)=0$, $u(1,t)=0$; $u(x,0)=x(1-x)$.

Standard complex tasks for the acquired skills control:

1. The string ends fixed at the points $x = 0$ and $x = l$, are pulled at the initial time moment at the point $x = c$ and released without initial velocity. Determine $u(x, t)$ if $u(c, 0) = h$.

2. The string ends fixed at the points $x = -l$ and $x = l$, at the initial moment of time have a parabolic shape with apex at the point $u\ 0{,}0 = h$, then the string is released without initial velocity. Define $u(x, t)$.

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.