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: Solids and structures
(Name)

Form of education: Full-time
(Full-time /full-time – correspondence/correspondence)

Level of higher education: Bachelor's degree
(Bachelor's program/specialist program/
Master's program)

Workload in hours (in credits): 180(5)
(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)

Perm 2021

1. GENERAL PROVISIONS

1.1. GOALS AND OBJECTIVES OF THE COURSE

The goal of the course is to develop a set of knowledge in the field of engineering calculations for the strength, rigidity and stability of the elements of the structures that ensure the required reliability and safety of the products.

Objectives of the Course:

- to study of the theoretical basis and methods of calculating the strength, rigidity and stability of the elements of structures and machines;
- to be able to make calculations on the strength, rigidity and stability of typical elements of structures;
- to have the skill of determining the basic mechanical properties of materials based on standard laboratory tests.

1.2. STUDIED OBJECTS OF THE COURSE

- Engineering calculations on the strength and rigidity of frameworks, working on tension and compression, shift, torsion, bending;
- Testing methods to determine the characteristics of the strength, plasticity and elasticity of materials;
- The basics of the theory of tension and deformed state at the point of the body;
- Classical strength theories and materials plasticity criteria;
- Calculations for strength and rigidity in complex loading of products;
- Calculations on the stability of compressed rods
- Calculations for strength in the dynamic and cyclical loading of products.

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 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
GPC-1	IA-1_{gpc-1}	**To know** basic concepts and hypotheses used in the "Solids and structures" course. Knows basis for calculating the elements of the structures in complex types of load.	**Knows** principle features of modelling mathematical, physical and chemical processes assigned for definite technological processes.	Exam

1	2	3	4	5
	IA-2$_{gpc-1.}$	**To be able to** calculate the durability, rigidity and stability of frameworks	**Is able to** use general laws of the disciplines of mechanical-engineering module; to use general laws of natural-scientific disciplines, the rules of technical drafting and plotting.	Coursework, exam
	IA-3$_{gpc-1}$	**To master the skills** to choose the optimal sizes and shapes of cross-section rods that provide the required reliability, safety and cost-effectiveness.	**Masters** basic procedures of technological and economic analysis, has the skill of drafting as a member of the creative team; participates knowledgeably in the work aimed at production processes improvement using experimental data and results of modelling; masters business interaction with maintenance department and can estimate their recommendations taking into account experimental work of the enterprise technological department.	Coursework, exam
GPC-2	**IA-1**$_{gpc-2}$	**To know** standard testing methods to determine the mechanical properties of materials. Knows the essence of the processes and phenomena that occur when materials are deformed	**Knows** vital differences in approach to the project engineering of technical facilities, systems and technological processes.	Exam
	IA-2$_{gpc-2}$	**To be able to** determine the mechanical characteristics of materials based on laboratory tests.	**Is able to** determine the demand for commercial material necessary for making the detailed design; analyze the realization of the detailed design requirements in the course of technological process; correct project data owing to his competence; estimate convergence of calculation results obtained by different procedures.	Coursework, exam
	IA-3$_{gpc-2}$	**To master the skills** of self-work in the laboratory by experimental determination of mechanical properties of structural materials	**Masters the skills of** collection and processing primary materials as assigned by the management of the project department; the skills of efficient fulfillment of the detailed design; the skills of computer work with realization of new methods and software packages.	Coursework, exam

3. FULL TIME AND FORMS OF ACADEMIC WORK

Form of academic work	Hours in all	Distribution in hours according to semesters
		Number of semester
		3
1. Holding classes (including results monitoring) in the form: 1.1.Contact classwork, including:	54	54
– lectures (L)	16	16
– laboratory work (LW)	18	18
– 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)	90	90
2. Intermediate attestation		
Exam	36	36
Grading test		
Test (Credit)		
Course Project (CP)		
Course Work (CW)	+	+
Workload in hours	**180**	**180**

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
Semester 3				
Tension and compression, shear and torsion, geometric characteristics of flat sections The goals and objectives of the Solids and structures. concept of strength, rigidity, stability. Identification of internal force factors. Mechanical characteristics of materials. Moments of inertia of the simplest figures. Analysis of internal force factors for shear and torsion.	6	6	6	35
Straight bending. The concepts of bending. Types of bend. Determining the stresses and deformations of bending.	6	6	6	30
A stress-strain state at the point of the body, complex strength, fatigued strength of materials, stability of compressed rods. Components of a stress-strain state at the point of the body. Potential deformation energy. Types of complex load. Mechanical characteristics of fatigue resistance. Effect of rod conditions on critical force.	4	6	6	25
Total with regard to semester	16	18	18	90
Total with regard to the course	16	18	18	90

Topics of exemplary practical work

Sl.№	Topic of practical (seminar) work
1	Calculating the strength and definition of deformations of rod systems that work on tension and compression.
2	Determining the geometric characteristics of planar sections.
3	Calculations for strength and rigidity at torsion.
4	Identify internal force factors when bending. Building a diagram of internal force factors. Calculating the beam for strength by normal stress.
5	A complete test of the strength of the I-beam.
6	Determining deformations when bending.
7	Analysis of a planar stress-strain state at the point of the body.
8	Calculations for strength in complex resistance: asymmetric bend, bend with torsion.
9	Calculating shafts to resist multi-cycle fatigue. The calculation for the stability of the centrally compressed rod.

Topics of exemplary laboratory practice

Sl.№	Topic of laboratory work
1	Testing for stretching plastic and fragile materials. Identify the basic characteristics of the strength and plasticity of the material.
2	Testing for compression of plastic and fragile materials. Experimental definition by tendometrical characteristics of the material: the Jung module and the Poisson coefficient.
3	Determining the shear modulus of elasticity on the results of the test on the torsion of the thin-walled tube.
4	Experienced definition of deformations when bending in the specified sections of the beam.
5	Experienced definition of the movements of the console beam at the asymmetric bend.

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.

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 units 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	2	3
	1. Basic literature	
1	C. Ross, J. Case, A. Chilver, Strength of Materials and Structures, Oxford, Butterworth-Heinemann, 2003, 706 p.	1
	2. Additional literature	
	2.1. Educational and scientific literature	
1	R.K. Bansal, Engineering Mechanics and Strength of Materials, New Dehli, Laxmi Publications, 2044, 881p.	1
2	Sobotka Z. Rheology of Materials and Engineering Structures. Prague : Academia, 1984. 548 p.	1
3	Proceedings of the 7th Israeli-Russian Bi-National Workshop "The Optimization of Composition, Structure and Properties of Metals, Oxides, Composites, Nano- and Amorphous Materials", Perm, August, 4-11, 2008 / Perm, 2008. 207 p.	1
4	Beer F. P., Johnston E. R. Mechanics for Engineers. Statics : Statics. 4th ed New York : McGraw-Hill Book Company, 1987. 448 p.	1

1	2	3
5	Emel'yanycheva E. A., Abdullin A. Fundamentals of Chemical Engineering of Hydrocarbon Processing. SPb, 2018. 95 p.	1
6	Bonnelle J. P., Delmon B., Derouane E. Surface Properties and Catalysis by Non-Metals. Dordrecht : D. Reidel Publishing Company, 1983. 562 p.	1
7	Rajasekaran S, Sankarasubramanian G Essentials of Engineering Mechanics. 2 ed New Delhi : Vikas Publ. House PVT LTD, 2006. [658 p.]	1
2.2. Standardized and Technical literature		
3. Students' manual in mastering discipline		
4. Teaching and learning materials for students' self work		

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	International Journal of Solids and Structures	*https://www.journals.elsevier.com/international-journal-of-solids-and-structures*	Internet
Additional literature	Latin American Journal of Solids and Structures	*https://www.lajss.org/index.php/LAJSS*	Internet
Additional literature	Strength of Materials	*https://www.springer.com/journal/11223*	Internet

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
Office Applications	Microsoft Office

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/
Scientific electronic library database (eLIBRARY.RU)	https://elibrary.ru/

Branding	Reference to information resource
Scientific Library of the Perm National Research Polytechnic University	https://lib.pstu/
Lan Electronic Library System	https://e.lanbook.com/
Electronic library system IPRbooks	https://www.iprbookshop.ru/
Information resources of the Network ConsultantPlus	https://www.consultant.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
Lab equipment class	Models and stands for laboratory work	25

8. FUND OF THE COURSE EVALUATING TOOLS

In the separated file