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 2021

ACADEMIC COURSE WORKING PROGRAM

Academic course: Machine parts and basic design
(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)

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1. GENERAL PROVISIONS

1.1. GOALS AND OBJECTIVES OF THE COURSE

Acquisition of a set of knowledge, skills, skills in the field of analysis and engineering calculations of parts and units of machines, design of machines and mechanisms, taking into account the set of requirements for mechanical engineering products

1.2. STUDIED OBJECTS OF THE COURSE

– general principles and methods of designing machine parts and assemblies;
– the main types of transmission mechanisms;
– typical machine parts: shafts, axles, sliding and rolling bearings, mechanical couplings;
– connections of parts;
– calculation methods based on performance criteria

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-2	**IA-1$_{gpc-2}$**	**To know** – classification of mechanisms, assemblies and parts; – requirements for parts, performance criteria and factors influencing them; – mechanical transmissions: gear, worm, planetary, wave, lever, friction, belt, chain, screw-nut transmission; strength calculations of gears; – shafts and axles, structures and strength calculations; rolling and plain bearings, selection and strength calculations; elastic elements; couplings; – connections of parts: threaded, keyed, toothed, with interference, pin, profile; riveted, welded, brazed, glue, structures and strength calculation	**Knows** vital differences in approach to the project engineering of technical facilities, systems and technological processes.	Exam

1	2	3	4	5
GPC-2	**IA-2$_{gpc-2}$**	**To be able to** – analyze the work of individual parts, units and mechanisms of machines; – determine the loads, draw up design schemes that correspond to the operating conditions of a particular structure; – apply standard methods of design and calculation of gears, shafts, bearings, connections of parts, taking into account the established requirements for parts, criteria for their performance and factors affecting them	**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.	Exam
GPC-2	**IA-3$_{gpc-2}$**	**To master the skills of** – the skills of analyzing the device and the principle of operation of mechanisms and units of machines; – skills in design and calculation of standard parts and machine assemblies, taking into account the established requirements for parts, criteria for their performance and factors influencing them.	**Masters the skills of** collection and processing primary materials as assigned by the management of project department; the skills of efficient fulfillment of the detailed design; the skills of computer work with realization of new methods and software package.	Course Project, exam
GPC-6	**IA-1$_{gpc-6}$**	**To know** – the basics of designing mechanisms, the stage of development of design documentation; – requirements for parts, performance criteria and factors influencing them, calculation methods for performance criteria; – design of typical ma-chine parts, bearing as-assemblies, body parts, sealing devices.	**Know** the principles of information-communication technologies and basic information security requirements.	Exam
GPC-6	**IA-2$_{gpc-6}$**	**Be able to** – to design standard parts and units of machines in accordance with the terms of reference; – to select and use reference literature, standards, structural prototypes in the design; – to develop design documents at various stages of design.	**Is able to** solve standard tasks of professional activity on the basis of informational and bibliographic culture with the use of modern technologies and information security requirements.	Exam
GPC-6	**IA-3$_{gpc-6}$**	**To master the skills** – in engineering calculations and design of standard parts and machine assemblies using reference literature, design automation tools; – in the development of design documentation.	**Masters the skills** of solving standard problems of professional activity on the basis of modern information technologies and information security requirements.	Course Project, 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
		5
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)	36	36
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
1	2	3	4	5
5 semester				
Fundamentals of designing mechanisms and machines	2	2	2	12
Classification and basic requirements for parts and assemblies of machines Classification of machines and mechanisms. Typical parts and units of machines – parts and units of machines for general purposes. Classification signs of assemblies and parts. Requirements for parts and assemblies of machines: functional, operational, production and technological, ergonomic requirements, etc. The set of requirements and product quality. Efficiency, reliability, manufacturability, efficiency. Performance criteria and factors influencing them. Types and causes of malfunctioning. Strength. Loading types and fracture models. Real structures and design models. Features of strength analysis under static and variable loads. Constructive and technological methods for increasing strength. The rigidity of machine parts, its effect on the performance of the product. Methods for assessing stiffness. Stability. Heat resistance and vibration resistance of machine parts. Wear resistance. Types of wear. Methods for increasing wear				

1	2	3	4	5
resistance. Reliability and efficiency. Reliability indicators. Refusals. Probability of uptime. Principles and methods of design, stages of development General tasks and design principles. Engineering calculations are an organic component of design. Design schemes and design models. Design and verification calculations. The principle of calculating machine parts according to performance criteria.) Multivariance and multi criteria of design. The goal and objectives of optimal design. Design variables, constraints, optimality criteria. Forms of organization of the design process. Computer-aided design. Stages of machine design and development of design documentation. Terms of reference and initial design data. Technical proposal and draft design. Content and purpose of the technical proposal. Tasks and technical documents of preliminary design. Technical project.				
Mechanical transmission	6	6	6	45
Friction and belt drives Friction transmissions: principle of operation, classification, application. Kinematic and power relationships. Performance criteria. Calculation for contact endurance and wear. Friction variators: purpose, characteristics. Belt drives: principle of operation, types of transmissions, application, basic parameters and characteristics. Belt drive geometry and kinematics. Elastic sliding. Forces and tensions in the belt. (Performance criteria. Calculation of the belt drive in terms of traction capacity and durability. Ways to improve performance. Features of calculating gears with flat, V-belts and poly-V-belts. Mechanical transmissions: gear, planetary, wave Gear drives: classification, characteristics, application. Fundamentals of the theory of gearing. The main parameters of gears. Gear wheel designs. Features of geometry and kinematics of helical and chevron involute cylindrical gears. Forces in engagement. Types and causes of damage to gears, performance criteria. Gear materials, heat treatment, permissible stresses. Calculation of teeth for contact strength, calculation of teeth for bending strength. Planetary and wave gears: general information, basic structural elements. Worm gears and screw-nut gears Worm gears: classification, application, characteristics. Geometry and kinematics of the worm gear, gear ratio. Slip and friction in worm gear. Design features and parameters of worm wheels. Forces in engagement. Failure modes and performance criteria. Peculiarities of calculating gears for contact and bending endurance. Materials and allowable stresses. Efficiency. Thermal calculation. Screw-nut transmission: classification, characteristics, application.				

1	2	3	4	5
Chain and link drives Chain drives: principle of operation and application, basic parameters and characteristics. Types and designs of drive chains. Features of kinematics and dynamics. Lever gears: types of mechanisms, application.				
Shafts and axles. Bearings. Couplings	4	4	6	15
Shafts and axles Shafts and axles: classification, design, application. Failure modes and performance criteria. Design features, materials. Drawing up the design diagram of the shaft, shaft load. Calculation of shafts for static and fatigue strength. Rolling and sliding bearings. Seals Rolling bearings: application, design, classification, designation. Comparative characteristics of the main types of bearings. Damage types and performance criteria. Determination of the equivalent load. Practical selection and calculation of rolling bearings for static and dynamic load capacity. Bearing unit designs. Methods for fixing shafts using rolling bearings. Lubrication methods. Sealing devices. Plain bearings: application, designs, liner materials, lubricants, lubrication methods, friction modes. Failure modes and performance criteria. Couplings. Elastic elements. Body details Permanent couplings, controlled and self-controlled: purpose. Blind, elastic and compensating couplings: designs, selection, comparative characteristics. Compensating ability of couplings and additional loads on drive parts. Shock absorbing and damping capacity of couplings. Coupling controlled couplings: designs, application. Safety clutches, overrunning, centrifugal: designs, application. Elastic elements of couplings and other assemblies: purpose, classification, materials, basic parameters. General characteristics of non-metallic elastic elements. The main types of springs: general characteristics, basic parameters. Body parts of mechanisms. Constructions				
Connections	4	6	4	18
Threaded connections Threaded connections: characteristics, application. Classification and basic parameters of the thread. Efforts in a screw pair, efficiency. Types of damage and performance criteria for threaded connections. Calculation of a single threaded connection for different loading cases: unstressed threaded connection; connection loaded with tightening force; shear-loaded joint; joint loaded with forces that reveal the joint of parts. Features of the calculation and design of threaded connections, including a group of bolts. Connections of parts of revolution Keyed connections: general characteristics, application. Calculation and design of a stress-free keyway (parallel, segmental and cylindrical keys.				

1	2	3	4	5
Splined (gear) connections: characteristics, application. Centering methods. Calculation and design. Interference connections: application, assembly technology features. Damage types and performance criteria. Bearing capacity of cylindrical joints when loaded with axial force and torque. Fundamentals of tightness calculations, choice of fit. Pin connections: designs, application, strength calculation. Profile connections: designs, application. Permanent connections Welded joints: characteristics and application. Damage types and performance criteria. Allowable voltages. Calculation and design of joints made with butt and fillet welds. Soldered and adhesive joints: characteristics, application, calculation features. Riveted joints: application, classification, performance criteria, design features.				
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	Kinematic and power calculation of a mechanical drive
2	Calculation and design of gear, worm gears
3	Calculation and design of gears with flexible connection
4	Sketch design of an assembly unit including gear (worm) gears
5	Drawing up the design diagram of the shaft. Strength calculation
6	Selection of rolling bearings and calculation of their durability
7	Calculation and design of threaded connections
8	Calculation and design of joints of parts of revolution
9	Calculation and design of permanent connections

Topics of exemplary laboratory practice

Sl.№	Topic of laboratory work
1	Research of designs of gear reducers. Determination of the main parameters
2	Research of designs of worm gearboxes. Determination of the main parameters
3	Research of rolling bearing designs
4	Investigation of mechanical coupling designs

Topics of exemplary Course Project

Sl.№	Topics of exemplary Course Project
1	Mechanical drive design

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

The course project, carried out as part of the out-of-class independent work of students, allows you to consolidate design skills, gain experience in designing specific technical objects, and improve the skills of graphic design of design results.

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	
	A Textbook of Machine Design Karwa, Rajendra, 2005. – 748 p.	1
	Design of Machine and Structural Parts, Wiley-Interscience (October 1, 1987). – 222 p.	1
	2. Additional literature	
	2.1. Educational and scientific literature	
	Transactions of Machine Elements Division.On the Design of Spiral Bevel Gears / Lund Technical University. Lund, 1988. 72 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 assess)
Additional literature	Arthur C. D. The Disintegration Machine. SPb	*https://elib.pstu.ru/Record/lan3 9824*	local net

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)
Management systems for projects, research, development, design, modeling and implementation	Autodesk AutoCAD 2019 Education Multi-seat Stand-alone

6.4. MODERN PROFESSIONAL DATA BASES 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/
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

Described in a separate document

Ministry of Science and Higher Education of the Russian Federation

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FUND OF ESTIMATING TOOLS

For students' midterm assessment in the discipline
"Machine parts and basic design"
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)**: 5

Workload:
in credits: 3 CU
in hours: 108 h

The form of midterm assessment:
Exam 5 semester,
Course Project 5 semester

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Fund of estimating tools for midterm assessment of students' learning the subject "Machine parts and basic design" 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 fifth semester of curriculum) and is divided into four 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 "Machine parts and basic design" (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 classification of mechanisms, assemblies and parts; requirements for parts, performance criteria and factors influencing them; mechanical transmissions: gear, worm, planetary, wave, lever, friction, belt, chain, screw-nut transmission; strength calculations of gears; shafts and axles, structures and strength calculations; rolling and plain bearings, selection and strength calculations; elastic elements; couplings; connections of parts: threaded, keyed, toothed, with interference, pin, profile; riveted, welded, brazed, glue, structures and strength calculation	D1	AC1		T1		*TQ*

1	2	3	4	5	6	7
K.2 the basics of designing mechanisms, the stage of development of design documentation; requirements for parts, performance criteria and factors influencing them, calculation methods for performance criteria; design of typical ma-chine parts, bearing as-assemblies, body parts, sealing devices.	D2	AC2		T2		*TQ*
Acquired abilities						
A.1 analyze the work of individual parts, units and mechanisms of machines; determine the loads, draw up design schemes that correspond to the operating conditions of a particular structure; apply standard methods of design and calculation of gears, shafts, bearings, connections of parts, taking into account the established requirements for parts, criteria for their performance and factors affecting them			PWR 1-9		CoP	*PT*
A.2 to design standard parts and units of machines in accordance with the terms of reference; to select and use reference literature, standards, structural prototypes in the design; to develop design documents at various stages of design			PWR 1-9		CoP	*PT*
Mastered skills						
S.1 analyzing the device and the principle of operation of mechanisms and units of machines; skills in design and calculation of standard parts and machine assemblies, taking into account the established requirements for parts, criteria for their performance and factors influencing them			LWR 1-8		CoP	*CT*
S.2 engineering calculations and design of standard parts and machine assemblies using reference literature, design automation tools; development of design documentation			LWR 1-8		CoP	*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 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) progress check is carried out in the form of laboratory and practical work presentation and midterm control works (after learning every discipline module).

2.2.1. Presentation of laboratory and practical work

It is planned 8 laboratory work and 9 practical work all in all. Standard topics of laboratory and practical work are given in ACWP.

Presentation of laboratory and practical work is made by the student individually or by the group of students. Standard scale and criteria of assessment are given in the general part of FET of the educational program.

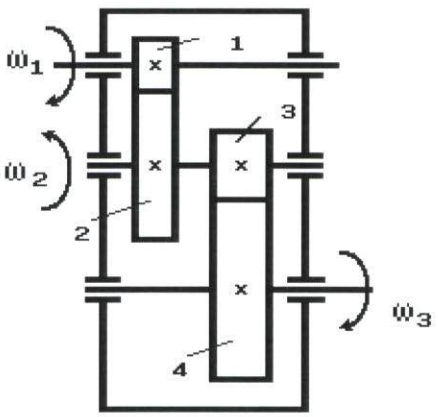
2.2.2. Midterm control work

According to ACWP 2 midterm control works (CW) are planned to be realized after learning the 2 and 4 educational modules of the discipline by the students.

The first CW is realized with respect to the module 1 and 2 "Basic design mechanisms and machines" and "Mechanical transmissions", the second CW – with respect to the module 3 and 4 "Shafts and axles", "Bearings", "Couplings" and "Connections".

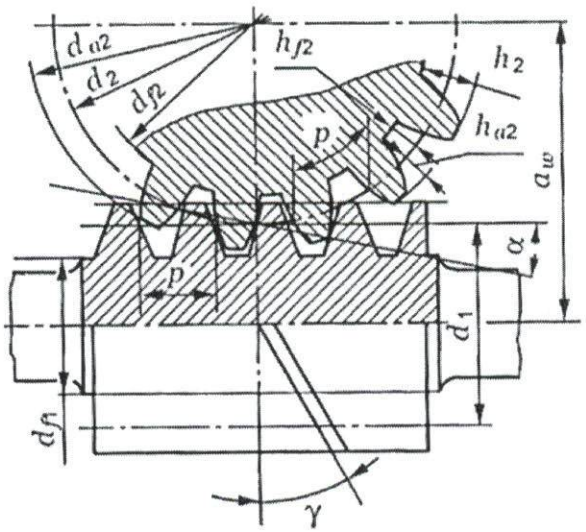
Standard tasks of the first CW:

1. The gear ratio of the high-speed stage of a cylindrical two-stage gearbox, if ω_3= 102 rad/s; ω_1 = 20, 4 rad/s; z_3= 17; z_4= 42:



1) 4,5
2) 12,35
3) 2,02
4) 5

2. Standard center distance, if z1 = 2; z2 = 32, q = 16, m = 4:

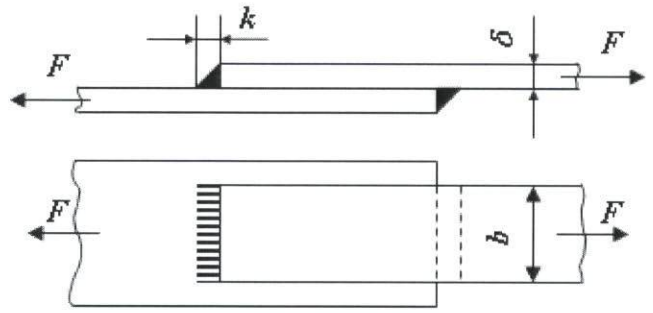


1) = 100 mm
2) = 125 mm
3) = 140 mm
4) = 160 mm

Standard tasks of the second CW:

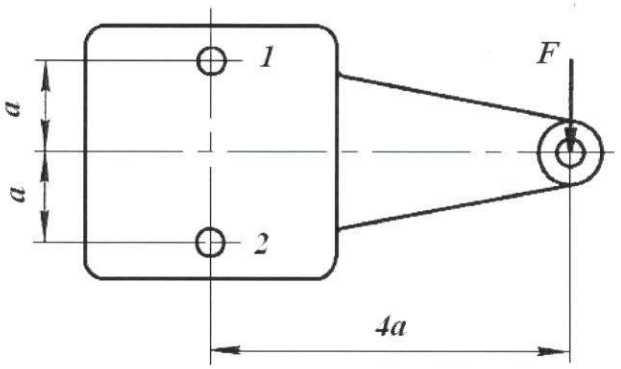
1. Permissible load for the connection shown in the figure, if k = 6 mm; b = 80 mm and permissible stress of the weld metal 72 MPa:

2.



1) 115,2 кN
2) 48,38 кN
3) 24,19 кN
4) 34,56 кN

2. Shear force on a loaded bolt and shear stresses in the body of a bolt installed in the holes of parts without clearance, if F = 4000 N, d = 20 mm:



1) $F_{сдв}$ = 8246 N; $\tau_{ср}$ = 26,3 N/mm^2
2) $F_{сдв}$ = 8600 N; $\tau_{ср}$ = 30,2 N/mm^2
3) $F_{сдв}$ = 7800 N; $\tau_{ср}$ = 36,2 N/mm^2
4) $F_{сдв}$ = 8420,5 N; $\tau_{ср}$ = 62,2 N/mm^2

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 INDIVIDUAL COURSE PROJECT

The implementation of the course project is a complex task, covers all topics of the course and represents design and construction solutions, taking into account the basic principles of design and construction of machines and mechanisms

2.3.1 Typical course project topics

Design a belt conveyor drive: the drive consists of an AIR series electric motor, a belt drive, a spur gear reducer and a coupling on the output shaft.

Content of the course project:

1. Kinematic and power calculation of the drive.
2. Calculation and design of gears.
3. Outline design of the gearbox.
4. Selection and calculation of rolling bearings.
5. Shaft design, strength calculation.
6. Selection of the coupling.
7. Execution of the assembly drawing of the gearbox.
8. Execution of working drawings of parts.
9. Development of design documentation.

Typical scale and criteria for assessing the results of the defense of the course project are given in the general part of the FOS 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 and practical 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 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. Classification of mechanisms, assemblies, machine parts studied in the course "Machine parts and design basics".
2. Criteria for the quality of units and parts of machines, and their brief description.
3. Safety reserves and permissible stresses in the calculation of parts.
4. Factors affecting the strength of parts.
5. The main stages of the design of mechanical engineering products, the design algorithm diagram.

Standard questions and practical tasks for the mastered abilities control:

1. Provide a rational choice of material for the manufacture of mechanical transmission parts.
2. To identify the main factors affecting the performance of mechanical transmissions.
3. To identify the criteria for the performance of rolling bearings and the factors affecting them.
4. Identify the main factors influencing the choice of the method of calculating the strength of the joints of parts.

Standard complex tasks for the acquired skills control:

1. Make power and kinematic calculations of mechanical transmission drives.
2. Determine the values of the performance criteria for mechanical transmissions.

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 got 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 got 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.