Federal State Autonomous Educational Institution of Higher Education
«RUDN University»

Engineering Academy

WORKING PROGRAM OF THE DISCIPLINE

Name of the discipline

Dynamics and strength of machines, devices and equipment

Recommended for the educational program

01.06.01 Mathematics and Mechanics

Focus of the program (profile)
«Dynamics and strength of machines, devices and equipment» (technical sciences)

1. Purposes and objectives of the discipline:

The purposes of the discipline "Dynamics and strength of machines, devices and equipment" are: mastering the basic laws of mechanics; acquaintance with the mechanical properties of materials; studying methods for calculating the strength, rigidity and stability of structural elements of machines, devices and equipment, and repairing them.

The objectives of the discipline are: acquisition of skills in the design of equipment elements; choice of calculation models of mechanical systems; development of methods for solving the equations of statics, kinematics and dynamics; knowledge of methods for strength calculations.

2. Place of the discipline in the structure EP HE:

The discipline "Dynamics and strength of machines, devices and equipment" refers to the variable part of block 1 of the curriculum.

Table 1 shows the previous and subsequent disciplines aimed at the formation of discipline competencies in accordance with the competence matrix of EP HE.

Table № 1

Prior and subsequent disciplines aimed at the formation of competencies

№	Code and name of competence	Preceding disciplines	Subsequent disciplines (groups of disciplines)
Universal competences			
1	ability to critically analyze and evaluate modern scientific achievements, generate new ideas when solving research and practical problems, including interdisciplinary areas (UC-1)	History and philosophy of science	Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
2	ability to plan and solve problems of professional and personal development (UC-5)	History and philosophy of science Research methodology Priority areas for the development of mathematics and mechanics Fundamentals of teaching methods for the development of engineering applications based on mathematical modeling using informatics and computer technology in higher education	
General professional competencies			
3	ability to independently carry out research activities in the relevant professional field using modern research methods and information and communication technologies (GPC-1)	Research methodology Priority areas for the development of mathematics and mechanics	Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
Professional competence			
4	willingness to apply promising research methods and solve professional problems, taking into account global trends in	Research methodology Priority areas for the development of mathematics and mechanics	Technology and engineering of nanodevices and systems System analysis, management and information processing

	the development of technical objects for various purposes (PC-1)		Modern problems of control theory
5	ability to identify the essence of scientific and technical problems arising in the course of professional activity, and to apply the physical and mathematical apparatus, theoretical, computational and experimental research methods, methods of mathematical and computer modeling, for solving the previously mentioned problems (PC-2)	Research methodology	Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
6	willingness to carry out research work and solve scientific and technical problems in the field of applied mechanics based on the achievements of engineering and technology, classical and technical theories and methods, physical-mechanical, mathematical and computational models that have a high degree of adequacy to real processes, machines and structures (PC-3)	Research methodology Priority areas for the development of mathematics and mechanics	Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
7	ability to create new generations of machines, devices, equipment, technologies and materials with qualitatively new functional properties, as well as to improve existing machines, devices, equipment and technologies with improved performance characteristics, less material and energy consumption (PC-4)	Fundamentals of teaching methods for the development of engineering applications based on mathematical modeling using informatics and computer technology in higher education	Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
8	ability to develop methods of mechanics and computational mathematics, computer technology and decision support systems in scientific research, design and engineering activities (PC-5)	Fundamentals of teaching methods for the development of engineering applications based on mathematical modeling using informatics and computer technology in higher education	Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
9	ability to study patterns and relationships, dynamic processes, stress states and	Priority areas for the development of mathematics and mechanics Fundamentals of teaching methods for the	Technology and engineering of nanodevices and systems System analysis, management and information processing

	strength of machines, devices and equipment (PC-6).	development of engineering applications based on mathematical modeling using informatics and computer technology in higher education	Modern problems of control theory

3. Requirements for the results of mastering the discipline:

The process of studying the discipline "Dynamics and strength of machines, devices and equipment" is aimed at the formation of the following competencies:

- ability to critically analyze and evaluate modern scientific achievements, generate new ideas when solving research and practical problems, including interdisciplinary areas (UC-1);
- ability to plan and solve problems of professional and personal development (UC-5);
- ability to independently carry out research activities in the relevant professional field using modern research methods and information and communication technologies (GPC-1);
- willingness to apply promising research methods and solve professional problems, taking into account global trends in the development of technical objects for various purposes (PC-1);
- ability to identify the essence of scientific and technical problems arising in the course of professional activity, and to apply the physical and mathematical apparatus, theoretical, computational and experimental research methods, methods of mathematical and computer modeling, for solving the previously mentioned problems (PC-2);
- willingness to carry out research work and solve scientific and technical problems in the field of applied mechanics based on the achievements of engineering and technology, classical and technical theories and methods, physical-mechanical, mathematical and computational models that have a high degree of adequacy to real processes, machines and structures (PC-3);
- ability to create new generations of machines, devices, equipment, technologies and materials with qualitatively new functional properties, as well as to improve existing machines, devices, equipment and technologies with improved performance characteristics, less material and energy consumption (PC-4);
- ability to develop methods of mechanics and computational mathematics, computer technology and decision support systems in scientific research, design and engineering activities (PC-5).
- ability to study patterns and relationships, dynamic processes, stress states and strength of machines, devices and equipment (PC-6).

4. Scope of the discipline and types of educational work:

The total workload of the discipline is **4 credit units (144 h.).**

Type of educational work	**Total hours**	**Semester**
		4
Auditory lessons (total)	**144**	144
Including:		
Lectures	**-**	-
Practical lessons	**58**	58
Seminars	**-**	-
Laboratory work	**-**	-
Independent work (total)	**50**	50

Control		**36**	36
Total workload	**hours**	**144**	144
	credits	**4**	4

5. Discipline content

5.1. Contents of the discipline sections

№	Name of the discipline section	Section content
1.	Basic concepts of mechanics. Fundamentals of Structural Materials Mechanics.	Mechanical reliability issues in mechanical engineering. Economic aspects of the dynamics and strength of machines. Basic hypotheses. Real structures and their design schemes. Sectioning method. Internal power factors. Types of bar deformations. General assumptions about the properties of materials. Concepts of stresses and strains. Stress tensor. Reciprocity law for shearing stresses. Principal sites and principal stresses. Particular cases of stress.
2.	Basic concepts of the theory of machines and structures reliability. Stability of structural elements	Basic concepts of the theory of structural reliability. Failures, defects, durability, and service life of machines and structures. Limit state. Limit and permissible stresses. Safety factor and its statistical justification. Strength calculation for permissible stresses. Choice of the standard safety factor. Kinematic characteristics of oscillatory processes.
3.	Bending calculations. Torsion and shear calculations. Shafts and springs. Revolution shells calculations.	Geometric characteristics of flat sections: static moments, axial and centrifugal moments of inertial sections. Calculation of the center of gravity position of the section. Main central axes of the section. Standards for rolled profiles. Torsion of an elastic cylindrical rod. Shear stresses and torsion angle. Torsional strength and stiffness condition. Potential energy of elastic deformation. Basic concepts of the theory of elastic stability. Stable and unstable equilibrium states. Stability of a straight bar under longitudinal compression. Critical strength. Euler's formula and the limits of its application.

5.2. Discipline sections and types of classes (full-time education)

	Name of the discipline section	Lectures	Practical lessons	Lab. work	Semin	CPC	Total hours
	4 semester						
1.	Basic concepts of mechanics. Fundamentals of Structural Materials Mechanics.		20			16	**36**
2.	Basic concepts of the theory of machines and structures reliability. Stability of structural elements		20			16	**36**
3.	Bending calculations. Torsion and shear calculations. Shafts and springs. Revolution shells calculations.		18			18	**36**
	Credits						**36**
	Total:		**58**	**-**	**-**	**50**	**144**

6. Laboratory workshop is not provided.

7. Practical lessons (seminars)

№	Number of the discipline section	Practical lessons topics	Labor intensity (hours)
1.	1	Basic concepts of mechanics.	10
2.	1	Fundamentals of Structural Materials Mechanics.	10
3.	2	Basic concepts of the theory of machines and structures reliability.	10
4.	2	Stability of structural elements.	10
5.	3	Bending calculations. Torsion and shear calculations.	9
6.	3	Shafts and springs. Revolution shells calculations.	9
	Total		**58**

8. Material and technical support of the discipline:

Classroom with the list of material and technical support	Address
Classrooms No. 554 for lecture-type classes, practical lessons, group and individual consultations, monitoring and intermediate assesment. A set of specialized furniture: hardware: plasma TV Samsung PS-50 A410C1	Moscow, st. Ordzhonikidze, 3

9. Informational support for the discipline:

The implementation of the educational process of the discipline is based on the use of the following information technologies:

1. EBS of RUDN University and third-party EBS, to which PhD students have access within the framework of agreements:

- E-library of RUDN University - EBS RUDN http://lib.rudn.ru/MegaPro/Web
- EBS «Universitetskaya biblioteka onlajn» http://www.biblioclub.ru
- EBS Yurajt http://www.biblio-online.ru
- EBS «Konsul'tant studenta» www.studentlibrary.ru
- EBS «Lan'» http://e.lanbook.com/

2. Websites of ministries, agencies, services, manufacturing enterprises and companies whose activities are the main line of this discipline:

- https://www.mos.ru/mka/
- http://www.minstroyrf.ru/

3. Databases and search engines:

- electronic fund of legal and normative-technical documentation http://docs.cntd.ru/
- Yandex https://www.yandex.ru/
- Google https://www.google.ru/
- SCOPUS abstract database http://www.elsevierscience.ru/products/scopus/

10. Educational-methodical and informational support for the discipline:

a) Main Literature:

English

1. EBS «Znanium. som.» Yatsun S. F.Kinematika, dinamika i prochnost' mashin, priborov i apparatury: uchebnoye posobiye / S.F. Yatsun, V.YA. Mishchenko, Ye.N. Politov. - M.: Al'fa-M: Infra-M, 2012. - 208 s. - Rezhim dostupa: http://znanium.com/

b) Additional Literature:

English

1. EBS «Znanium. som.» Khrunicheva, T.V. Detali mashin: tipovyye raschety na prochnost': uchebnoye posobiye / T.V. Khrunicheva. - M.: FORUM: INFRA-M, 2007. - 224 s. - Rezhim dostupa: http://znanium.com/

2. EBS «Znanium. som.» Matveyev, YU. A. Teoriya mekhanizmov i mashin: uchebnoye posobiye / YU.A. Matveyev, L.V. Matveyeva. - M.: Al'fa-M: INFRA-M, 2009. - 320 s. - Rezhim dostupa: http://znanium.com/

3. Tekhnologiya tonkikh plenok i pokrytiy: uchebnoye posobiye / L. N. Maskayeva, Ye. A. Fedorova, V. F. Markov ; pod obshchey redaktsiyey L. N. Maskayevoy ; Ministerstvo obrazovaniya i nauki Rossiyskoy Federatsii, Ural'skiy federal'nyy universitet imeni pervogo Prezidenta Rossii B.N. Yel'tsina. — Yekaterinburg : Izdatel'stvo Ural'skogo universiteta, 2019. — 236 s. — ISBN 978-5-7996-2560-3.

11. Methodical instructions for students in order to assimilate the discipline (module):

The concept of modernization of Russian education defines the main objectives of professional education: “training a qualified employee of the appropriate level and profile, competitive in the labor market, competent, responsible, fluent in his profession and oriented in related fields of activity, capable of effective work in his specialty at the level of world standards, ready for continuous professional growth, social and professional mobility; satisfaction of the needs of the individual in obtaining the appropriate education.”

The consecution of these objectives is impossible without such an element of teaching as the independent work of students on educational material. However, the quality of independent work can be improved only with a responsible attitude of the teacher for developing the skills of independent work and increasing the creative activity of students.

During the practical lessons, the student is encouraged to outline the main content of the course. When teaching a discipline, it is methodologically expedient to highlight the most important points in each section of the course and focus the attention of students on them. It is advisable when conducting practical lessons in all sections of the program to illustrate practical material with a large number of examples, which makes it possible to enhance the clarity of the presentation and demonstrate to the student how to solve problems.

In the process of mastering the discipline, within the framework of independent work, the student works with literature in the library of RUDN University; uses the resources of the information and communication network "Internet".

Features of the discipline implementation for people with disabilities.

The discipline for people with disabilities is carried out by the teacher, taking into account the characteristics of psychophysical development, individual capabilities and health status of such students.

For students with impaired musculoskeletal function and hearing disabilities, it is provided to accompany the lectures and practical lessons with multimedia tools, handouts.

For students with visual disabilities, the use of technical means for enhancing residual vision is provided, and the possibility of developing audio materials is also provided.

In this discipline, training of people with disabilities can be carried out both in the classroom and remotely using the capabilities of the electronic educational environment (Educational Portal) and e-mail.

During the classroom lessons, various means of interactive learning are used, including group discussions, brainstorming, business games, project work in small groups, which makes it possible to include all participants in the educational process in active work on mastering the discipline. Such teaching methods, aimed at teamwork, discussion, group decision-making, contribute to group cohesion and provide opportunities for communication not only with the teacher, but also with other students, cooperation in the process of cognitive activity.

The training of people with disabilities can be carried out according to an approved individual schedule, taking into account the characteristics of their psychophysical development and health status, which implies the individualization of the content, methods, pace of the student's learning activity, ability

to follow the student's specific actions when solving specific problems, making the required adjustments in the training process.

Individual consultations will be provided (including counseling via e-mail), and also additional educational and methodological materials (depending on the diagnosis).

12. Fund of assessment tools for intermediate assessment of students in the discipline (module):

In accordance with the requirements of the OS VO RUDN University, for assessment of students for the compliance of their personal achievements with the planned learning outcomes in the discipline, funds of assessment tools have been created (FAT is presented in Appendix 1).

The teacher has the right to change the number and content of assignments given to the student (learner), based on the contingent (level of preparedness).

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