National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of
Biomedical Engineering

Mechanics

Work program of the discipline (Syllabus)

Details of the discipline

Level of higher education	***First (bachelor's)***
Branch of knowledge	*16 Chemical and bioengineering*
Specialty	*163 Biomedical Engineering*
Educational program	*Medical Engineering*
Discipline status	*Normative*
Form of study	*full-time / day / remote*
Year of preparation, semester	*2nd year, spring semester*
The scope of discipline	*4.5 ECTS credits (36 hours - lectures, 36 hours - practical, 63 hours - independent work)*
Semester control / control measures	*Test / MCR, CGW*
Lessons schedule	*According to the schedule on the website http://rozklad.kpi.ua/*
Language of instruction	*English*
Info for erivnyk and course / coaches in	*Lecturer: Ph.D., Associate Professor of biosafety and human health Antonova-Rafi Yuliia, antonova-rafi@ukrl.net* *Practical: PhD, Associate Professor, Andriy Vyacheslavovich Solomin, a.solomin@kpi.ua ; andr-sol@i.ua*
Course placement	*Sikorsky Platform, Mechanics Course* *https://do.ipo.kpi.ua/course/view.php?id=4213*

The program of discipline

1. Description of the discipline, its purpose, subject of study and learning outcomes

The discipline " Mechanics " plays a significant role in the preparation of bachelors in the specialty 163 "Biomedical Engineering". Study subjects promotes engineering thinking and allows the use of approaches, methods and knowledge of mechanics at mastering other disciplines of special profile, lays the foundation for professional competence.

The discipline studies the basic concepts and laws of theoretical mechanics and their consequences; the motion of material bodies, the interaction between them, as well as the conditions of equilibrium of body systems; methods for determining the kinematic and dynamic characteristics of mechanical systems, solids and individual points of the body; basic concepts and definitions of material resistance; methods of application of the theoretical apparatus of mechanics in solving practical problems of biomedical engineering.

The purpose of discipline is to develop in students competencies in line with the educational professional program "Medical Engineering" (order NON / 89/2021 of 04/19/2021):

General competencies

GC 1 Ability to apply knowledge in practical situations.

GC 2 Knowledge and understanding of the subject area and understanding of professional activity.

GC 3 Ability to communicate in the state language both orally and in writing.
GC 4 Skills in the use of information and communication technologies.
GC 5 Ability to perform research at the appropriate level.
GC 6 Ability to search, process and analyze information from various sources.
GC 7 Ability to generate new ideas (creativity).
GC 8 Ability to make well-grounded decisions.
GC 9 Ability to communicate with representatives of other professional groups of different levels (with experts from other fields of knowledge / types of economic activity).
GC 10 Safe activities skills.
GC 11 Ability to evaluate and ensure the quality of work performed.

Professional competencies

PC 3 Ability to study and apply new methods and tools for analysis, modeling, design and optimization of medical devices and systems.
PC 5 Ability to apply physical, chemical, biological and mathematical methods in the analysis, modeling of the functioning of living organisms and biotechnical systems.
PC 6 Ability to effectively use tools and methods for analysis, design, calculation and testing in the development of biomedical products and services.
PC 9 Ability to identify, formulate and solve engineering problems related to the interaction between living and non-living systems.

Program learning outcomes

PLO 24 Apply knowledge of the basics of mathematics, physics and biophysics, bioengineering, chemistry, engineering graphics, mechanics, resistance and strength of materials, properties of gases and liquids, electronics, computer science, obtaining and analyzing signals and images, automatic control, systems analysis and decision making methods at a level required to solve the problems of biomedical engineering.
PLO 31 Understanding of theoretical and practical approaches to the creation and management of medical equipment and medical technic.

According to the requirements of the program of the discipline "Mechanics" , students must demonstrate the following learning outcomes:

knowledge:

basic definitions and laws of theoretical mechanics;

skills:

- explain the nature of the behavior of mechanical systems using the appropriate theoretical instruments;
- determine the equilibrium conditions of the mechanical system;
- to study the mechanical motion of objects, using the basic theorems of dynamics;
- use general theorems of dynamics and methods of analytical mechanics in solving practical problems;
- to determine the internal force factors in the elements of mechanical systems, to identify dangerous sections, to assess the strength and rigidity.

2. Prerequisites and postrequisites of the discipline (place in the structural-logical scheme of education according to the relevant educational program)

The discipline belongs to the normative disciplines of the cycle of professional training and is based on knowledge of the disciplines : "Higher mathematics", "Physics-1", "Engineering

and computer graphics", "Materials science and construction materials".

Theoretical knowledge and practical skills acquired during the study of the discipline "Mechanics" are used in mastering the following disciplines: "Biomedical mechanics", "Engineering mechanics". "Therapeutic medical equipment", "Development and operation of physiotherapeutic medical devices".

3. The content of the discipline

List of sections and topics of the whole discipline

Section 1. Statics of a solid body

Topic 1.1. Introduction to mechanics. Basic concepts of statics.

Topic 1.2. Flat system of forces.

Topic 1.3. Arbitrary spatial system of forces. The moment of force about the axis.

Section 2. Kinematics

Topic 2.1. Kinematics of a point and the simplest motions of a rigid body.

Topic 2.2. Flat motion of a solid body.

Topic 2.3. Complex motion of a point and a rigid body.

Section 3. Dynamics

Topic 3.1. Basic theorems of dynamics.

Topic 3.2. Theorem on the change of kinetic energy of a mechanical system.

Topic 3.3. Analytical mechanics

Section 4. Resistance of materials

Topic 4. 1. Tension and compression. Testing of materials. Tense state.

Topic 4. 2. Shear and torsion.

Topic 4. 3. Bending.

4. Training materials and resources

Basic literature

1. R.S.Khurmi. A Textbook of Engineering Mechanics. – New Delhi: S.Chand & Company, 2017. – 766p.
   https://www.ktunotes.in/wp-content/uploads/2018/02/R.S._Khurmi_A_Textbook_of_Engineering_Mechanics.pdf
2. K.L.Kumar. Engineering Mechanics. - New Delhi: Tata McGraw-Hill Publishing Company, 2006. – 642p.
   https://drive.google.com/file/d/1U0Sw9a8u93uBPjWjWobK_76zvJD36z73/view
3. R.K.Bansal. A Textbook of Engineering Mechanics. – New Delhi: Laxmi Publications, 2005. – 157 p.
   https://wiac.info/doc-view
4. V.D.Ovsiannikov. Lecture notes for Physics. Part I. Mechanics. Voronezh, 2002. – 86p.
   https://do.ipo.kpi.ua/pluginfile.php/242469/mod_resource/content/4/LectureMechanics%20engl.pdf

Additional literature:

1. Павловський М.А. Теоретична механіка. – К.: Техніка, 2002. – 510 с.
2. Яблонский А.А. Курс теоретической механики: учебник для вузов / А.А. Яблонский, В.М. Никифорова. – М.: Высш. шк., 1984. – Ч. 1: Статика.

3. Яблонский, А.А. Курс теоретической механики: учебник для вузов / А.А. Яблонский, В.М. Никифорова. – М.: Высш. шк., 1984. – Ч. 2: Динамика. – 423 с.
4. Мильніков О.В. Опір матеріалів. − Тернопіль: Видавництво ТНТУ, 2010. − 257 с.
5. Сборник заданий для курсовых работ по теоретической механике / А.А. Яблонский [и др.]. – 15-е изд. – М.: Интеграл-Прес, 2006. – 384 с.
6. Теоретична механіка: Збірник задач / О.С. Апостолюк, В.М. Воробйов, Д.І. Ільчишина та ін .; За ред. М .А. Павловського. — К.: Т ехн іка, 2007. — 400 с.: іл. ISBN 966-575-059-3.

Educational content

5. Methods of mastering the discipline (educational component)

Names of sections and topics	Program learning outcomes	The main tasks	
		Control measure	Deadline
Section 1. Statics of a solid body			
Topic 1.1. Introduction to mechanics. Basic concepts of statics	PLO 24	Practical work 1	1st week
Topic 1.2. Flat system of forces	PLO 24	Practical work 2 Practical work 3 Practical work 4	2nd week 3rd week 4th week
Topic 1.3. Arbitrary spatial system of forces. The moment of force about the axis	PLO 24	Practical work 5	5th week
Section 2. Kinematics			
Topic 2.1. Kinematics of a point and the simplest motions of a rigid body	PLO 24	Practical work 6	6th week
Topic 2.2. Flat motion of a solid body	PLO 31	Practical work 7 Practical work 8	7th week 8th week
Topic 2.3. Complex motion of a point and a rigid body	PLO 31	Practical work 9	9th week
Section 3. Dynamics			
Topic 3.1. Basic theorems of dynamics	PLO 24, PLO 31	Practical work 10 Practical work 11	10th week 11th week
Topic 3.2. Theorem on the change of kinetic energy of a mechanical system	PLO 24, PLO 31	Practical work 12	12th week
Topic 3.3. Analytical mechanics	PLO 31	Practical work 13	13th week
Modular control work		Writing MCR / testing	13th week

Section 4. Resistance of materials			
Topic 4.1. Tension and compression. Testing of materials. Tense state	PLO 31	Practical work 14	14th week
Topic 4.2. . Shear and torsion	PLO 31	Practical work 15	15th week
Topic 4.3. Bending	PLO 31	Practical work 16	16th week
Calculation and graphic work (CGW)	PLO 24, PLO 31	Submission for verification. Presentation and defense of CGW	16 -17th week . 18th week

6. Independent student work

One of the main types of semester control during the mastering of the discipline "Mechanics" is the implementation of calculation and graphic work. Calculation and graphic work is performed in accordance with the requirements, within the period specified by the teacher.

The main purpose of computational and graphic work is to solve a practical problem using the material learned in lectures and independently, and practical skills acquired in practical work. The student can write calculation and graphic work only on the subject agreed with the teacher.

Exemplary topics of calculation and graphic work (CGW)

1. Determination of reactions of supports of a composite structure.
2. Absolutely solid body under the action of an arbitrary spatial system of forces. Determination of reactions of supports.
3. Calculation of forces in truss rods.
4. Kinematic analysis of spherical motion of a solid body rolling without sliding on a stationary surface.
5. Investigation of the motion of a mechanical system using the theorem on the motion of the center of mass.
6. Investigation of the motion of a mechanical system using the kinetic energy change theorem.
7. Investigation of the motion of a mechanical system using the general equation of dynamics

The structure of the CGW

Calculation and graphic work consists of the following structural elements: title page, tasks on CGW, calendar plan of CGW preparation, content, introduction, main part, conclusions, list of references, appendices.

The title page is the first page of the CGW. The title page should have the information provided in the following sequence: name of the ministry, name of the university; name of the faculty; name of department; name of academic discipline; CGW topic and its variant; level of higher education; code and name of the specialty; the name of the educational and professional program; surname and name of the student, course, number of the academic group; signatures of the teacher; the result of defense; year of CGW implementation .

On the next page, there is a task on the CGW, which contains information about: the deadline for the student to complete the work, initial data for work, a list of graphics, the date of the task, a detailed schedule of CGW with deadlines for individual stages of work.

Next is the table of contents, which distinguishes: introduction, main section with subsections (if necessary), conclusions, list of sources used, appendices (if necessary). The contents on the right indicate the page numbers at the beginning of each section. Each section begins on a new page.

The introduction of the CGW should contain: relevance, purpose and objectives, subject and methods of research.

The main section provides an analysis of literature sources, problem formulation, calculation schemes and their description, problem solving, tables, graphs, charts, etc. Mandatory requirement - a clear reference to sources of information in this form [2, p. 54] (the first digit means the source number in the bibliography at the end of the CGW, and the second digit - the page number in this source).

Conclusions should contain an assessment of the completeness of the solution of the tasks and the experience gained in performing CGW work.

The list of used sources (not less than 5 sources) is made out according to operating rules. If the information is taken from the Internet, you need, as for ordinary literature, specify the author, the title of the article, and then provide the site address on the Internet.

The appendices may include: additional diagrams or tables, a description of computer programs used in the process of performing CGW, etc.).

The total amount of CGW can vary from 15 to 20 pages of the main text, which depends on the student's ability to briefly and comprehensively reveal the topic.

Registration of CGW

Registration of CGW is carried out according to DSTU 3008:2015 “Information and documentation. Reports in the field of science and technology. Structure and registration rules”.

CGW must be printed on a standard sheet of format A4 with the following requirements: left field - 30 mm, right - 15 mm, top - 20 mm, bottom -20 mm; Times New Roman font size 14 pt; line spacing - 1.5; indentation of the red line - 1.25; text alignment - width.

Each structural element of the content of the work begins with a new page. The names of the structural elements should be placed in the center of the line without a dot at the end, without underlining, separated from the text by three line spacing. The transfer of syllables in words is not used. Figures and tables must have headings and numbering consistent with the section number.

Assessment of CGW

CGW work is evaluated by the following criteria:

- Timeliness of execution.
- The presence of all points of the methodology of solving problems. Sequence and correctness of calculations.
- Content and completeness of the topic.
- Quality of graphic material (calculation schemes, tables, figures).
- Compliance of CGW with design requirements and regulations.
- The degree of mastery of theoretical material and methods of solving the problem;
- Consistency and correctness of calculations .
- Substantiation of own opinion, logic and objectivity of conclusions;
- Quality of presentation and report.

Policy and control

7. Policy of academic discipline (educational component)

Attending classes

Attending lectures and practical sessions is not mandatory. However, students are encouraged to attend classes, as they teach theoretical material, assess the level of its mastery during the oral survey, develop skills and abilities necessary to perform tasks in independent work.

The assessment system is focused on obtaining points for student activity, as well as performing tasks that can develop practical skills and abilities.

Control measures missed

Practical works submitted for inspection in violation of the deadline, but before the deadline for the current certification (or test / exam), are evaluated with penalty points.

Practical works submitted for inspection in violation of the deadline and after the deadline for the current certification (or test / exam) are not evaluated.

Calculation and graphic work, which is submitted for inspection in violation of the deadline, is evaluated with penalty points.

Violation of deadlines and incentive points

Encouragement points		Penalty points*	
Criterion	Weight score	Criterion	Weight score
Active participation in oral interviews	+ 1 point	Violation of terms of practical works (for each such work)	-1 point
Participation in international, national and / or other events or competitions on the subject of the discipline	+ 5 points	Untimely writing of modular control work / testing	From -2 to - 8 points (depending on the delivery date)
		Late submission of CGW for evaluate	From -2 to - 16 points (depending on the delivery date)

**If the control measure was missed for a respectful reason (illness, which is confirmed by a certificate of the established sample) - penalty points are not accrued.*

Academic integrity

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”. Details: https://kpi.ua/code

Norms of ethical behavior

Norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”. Details: https://kpi.ua/code

Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures.

The student has the right to appeal the results of control measures in accordance with the Regulations on appeals in National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (order №NON /128/2021 from 20.05.2021) https://osvita.kpi.ua/node/182

Inclusive education

The discipline may be taught to the majority of students with special educational needs, with the exception of persons with severe visual impairments who are not allowed to perform tasks using personal computers, laptops and / or other technical means.

Distance Learning

Distance learning is through training platform "Sikorsky".

Implementation of practical work, modular control work / testing, calculation and graphic work done during independent work of students in remote mode with the possibility of consulting with the teacher via e-mail, platform ZOOM, social networks.

Learning a foreign language

Teaching in English is carried out only for foreign students.

At the request of students, it is allowed to study the material with the help of English-language online courses on topics that correspond to the topics of specific classes.

8. Types of control and rating evaluate system of learning outcomes (Rating System of Evaluation)

Types of control and scores for each control element

№ s / n	Control measure	%	Weight score	Number	Total
1.	Practical work	40	2.5	16	40
2.	Modular control work (MCW)/ Test	2 0	2 0	1	2 0
3.	Calculation and graphic work (CGW)	40	40	1	40
	Total				100

The results are announced to each student individually in the presence or remotely - in the Moodle system or by e-mail. In case of detection of plagiarism or establishment of non-independent performance of work, points for the control measure are not credited.

The applicant receives a positive credit score for the results of the semester, if he has a final rating for the semester of at least 60 points and has met the conditions of admission to the semester control, which are determined by the RSE (Rating System of Evaluation).

With applicants who have met all the conditions of admission to the test and have a rating of less than 60 points, as well as with those applicants who want to increase their rating, in the last scheduled lesson in the semester, the teacher conducts semester control in the form of test or interviews.

After performing the test, if the score for the test is higher than the rating, the applicant receives a score based on the results of the test.

If the grade for the test is lower than the rating, a "hard" RSE is used - the previous rating of the applicant (except for points for the semester individual task) is canceled and he receives a grade based on the results of the test. This option forms a responsible attitude of the applicant to the decision to perform the test, forces him to critically assess the level of his training and carefully prepare for the test.

Current control

Practical work

№ s / n	Evaluation criterion	Scores
1.	Complete answer (at least 90% of the required information)	2.5-2.3
2.	Sufficiently complete answer or complete answer with minor inaccuracies (not less than 75% of the required information)	2.2-1.9
3.	Incomplete answer and minor errors (at least 60% of required information)	1.8-1.5
4.	The answer is missing or incorrect	0

Modular control work / testing

№ s / n	Evaluation criterion	Scores
1.	Complete answer (at least 90% of the required information)	2 0 - 18
2.	Sufficiently complete answer or complete answer with minor inaccuracies (not less than 75% of the required information)	17 -1 5
3.	Incomplete answer and minor errors (at least 60% of required information)	1 4 -1 2
4.	The answer is missing or incorrect	0

Calculation and graphic work

№ s / n	Evaluation criterion	Scores
1.	Complete and timely execution of the task, error-free solution of the problem, the material is presented with knowledge of theoretical material, logically, consistently, with clarity (not less than 90% of the required information)	40-36
2.	The task is not complete enough or with some inaccuracies. Visual material is not used to the full (at least 75% of the required information).	35 - 30
3.	The task is not fully disclosed, partially or with some shortcomings. Visual material is insufficient (at least 60% of the required information).	29 - 24
4.	The task is incomplete and (or) with fundamental errors. Visual material is insufficient (less than 50% of the required information). There is no ownership of the material	0

Calendar control *(CC) -* is performed twice a semester as monitoring of the current state of compliance with syllabus requirements.

The purpose of calendar control is to improve the quality of student learning and monitor the implementation of the schedule of the educational process by students.

Criterion			The first CC	The second CC
Deadline of calendar controls			8th week	14th week
Conditions for obtaining a positive result from the calendar control	Current rating		≥ 10.5 points	≥ 22 , 5 points
	Performing practical work	№ № 1-7	+	-
		№ № 8-14	-	+
	Performing MCR / testing	MCR / testing	-	+
	Execution of calculation and graphic work	Calculation and graphic work	-	-

In case of detection of academic poor quality during training - the control measure is not credited.

Semester certification of students

Mandatory condition for admission to the test	Criterion
Current rating , including:	RD ≥ 60
- implementation of MCR / testing	not less than 60% of the maximum score
- protection of calculation and graphic work	not less than 60% of the maximum score
All practical works are tested	not less than 60% of the maximum score

The results are announced to each student separately in the presence or remotely (by e-mail). Also recorded in the system "Electronic Campus".

Optional conditions for admission to closure:

1. Activity in practical classes.
2. Activity in laboratory classes.
3. Positive result of the first attestation and the second attestation.

Test is a type of semester control in which the student's mastery of educational material is assessed on the basis of the results of current control. To receive a " automatically" test you must have a rating of at least 60 points.

Students who have a rating of less than 60 points at the end of the semester, as well as those who want to increase their rating, in the last scheduled class pass the semester control in the form of a test.

The test is conducted orally, is evaluated in 60 points and consists of four questions / tasks, each of which is evaluated in 15 points.

The sum of points for calculation and graphic work is added to the estimation which the student receives for testss in control work and this rating estimation is final.

№ s / n	Criteria for evaluating each question / task test control work	Number of points for each question / task
1.	Complete answer, not less than 90% of the required information, performed in accordance with the requirements for the level of "skills" (complete, error-free solution of the problem)	15 – 13,5
2.	Sufficiently complete answer, at least 75% of the required information, performed in accordance with the requirements for the level of "skills" or there are minor inaccuracies (complete solution of the problem with minor inaccuracies)	13 – 11,5
3.	Incomplete answer, at least 60% of the required information, which is performed in accordance with the requirements for the "stereotypical" level and there are some errors (the task is performed with certain shortcomings)	11 – 9
4.	The answer does not meet the conditions for "satisfactory"	0

When performing a test, students are not allowed to use textbooks, abstracts, reference books, phones, smartphones, PCs, etc.

Table of correspondence of rating points to grades on a university scale

Number points	*Assessment on the university scale*	*Possibility to receive an assessment "automatically"*
100-95	*Perfectly / Відмінно*	is
94-85	*Very good / Дуже добре*	is
84-75	*Good / Добре*	is
74-65	*Satisfactorily / Задовільно*	is
64-60	*Enough / Достатньо*	is
Less than 60	*Unsatisfactorily / Незадовільно*	-
Admission conditions are not met	*Not allowed / Не допущено*	-

9. Additional information on the discipline (educational component)

The list of questions for preparation for modular control work and test is given in Appendix 1

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a

specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Work program of the discipline (syllabus):

Compiled by: Associate Professor of Biomedical Engineering, PhD **Tarasova Larysa Dmytrivna**.
Approved by the Department of Biomedical Engineering (protocol № 13 to"25" June 2021).
Approved by the Methodical Commission of the faculty of Biomedical Engineering (Protocol №11 to "25" June 2021).

Appendix 1 to the syllabus of the discipline "Mechanics"

The list of questions for preparation for modular control work and test

1. Formulate the basic axioms of statics. Name the main types of elms. Give them a description. Elm reactions. Axiom about elm.
2. The concept of force and its properties. Rules for finding an equivalent. What is the difference between the resultant equivalent and with the equilibrium and balancing forces?
3. Rules for determining the equivalent system of two parallel forces of one direction and opposite directions that do not form a pair of forces. Explain with an example.
4. Distributed load. Determination of the concentrated force, the point of its application and the moment created by the distributed load.
5. Moment of force relative to the center. Properties of the moment of force relative to an arbitrary center. In which cases is the moment of force equal to zero?
6. The moment of force about the axis. In which cases the moment of force relative to an axis is equal to zero and how the sign of the moment is chosen Explain on an example.
7. Pair of forces and its main properties. Formulate a theorem on the equivalence of force pairs. Name the conditions under which two pairs will be equivalent.
8. Formulate and explain the theorem on the composition of pairs of forces placed in one plane and different planes.
9. Prove the theorem on the possibility of transferring a pair of forces in a plane parallel to the plane of its action.
10. Prove the theorem on the possibility of moving a pair of forces in the plane of its action. What transformations of a pair of forces do not change its action on a solid body?
11. Theorem on parallel force transfer. The basic theorem of statics (Poinso's theorem) – theorem on the reduction of an arbitrary system of forces to any center.
12. Reduction of the system of forces to the simplest system. Possible cases of reduction of a system of forces.
13. Analyze various cases of reduction of an arbitrary spatial system of forces to any center.
14. Equilibrium conditions of an arbitrary spatial system of forces, including the spatial system of parallel forces.
15. Equilibrium conditions of a plane system of forces. Three forms of the equilibrium condition of a plane system of forces.
16. Convergent system of forces. Theorem on the equivalent system of convergent forces. Equilibrium conditions of a convergent system of forces, including for a plane system of forces. Theorem on three forces. Explain with an example.
17. Varignon's theorem. Theorem on the moment of an equivalent system of convergent forces. Explain with an example.
18. Derive the dependence of the main moment of an arbitrary system of forces relative to the new center of reduction (the relationship between the main moments relative to two different centers of reduction). Invariants of statics.
19. Methods of solving statics problems. The difference between statically determinable and statically indeterminate statics problems. Explain with an example.

20. Equilibrium in the presence of sliding friction forces. What is the angle of friction, the cone of friction? To what extent does the sliding friction force change? Euler's formula.
21. Equilibrium in the presence of rolling friction forces. Formulas for determining the moment of rolling friction, within what limits does it change?
22. The center of gravity of a solid body. By what formulas are determined the radius-vector of the center of gravity, its coordinates? Explain with an example.
23. Methods of determining the centers of gravity of bodies. Give examples. How to determine the position of the center of gravity of the area, when the positions of the center of gravity of its individual parts are known?
24. The subject of kinematics. The main problem of point kinematics. Ways to set the motion of a point. Classification of point motion by acceleration. Coordinate systems
25. Mechanisms as the main objects of kinematics. Define the link of the mechanism, kinematic pair, riser, crank, connecting rod, rocker arm, slider, rocker.
26. What solid body movements are called simple? What is the motion of a rigid body called translational? The main properties of translational motion.
27. What equation describes the rotational motion of a rigid body around a fixed axis? How are the angle of rotation, angular velocity and angular acceleration of the body are connected? How are their vectors directed?
28. Euler's formula for determining velocity vectors and acceleration of body points. How are the tangent and normal components of the total acceleration vector directed?
29. What body motion is called flat-parallel or flat? What equations define the plane motion of the body? Determining the speed and acceleration of a point of a flat figure.
30. Formulate and prove the theorem on the projections of the velocities of two points of a body performing a plane motion. Explain with an example.
31. Define the instantaneous center of velocity. How are the positions of the instantaneous velocity center determined? Explain with an example.
32. Instant speed center (IMC) and ways to find it. How are the velocities of the points of a flat figure distributed relative to the IMC? Where is the IMC of a flat figure that performs instantaneous translational motion?
33. How is the acceleration of an arbitrary point of a flat figure determined? Give formulas
34. The concept of instantaneous acceleration center. Determining the position of the instantaneous acceleration center.
35. How are the accelerations of the points of a flat figure distributed relative to the instantaneous center of acceleration? Explain with an example.
36. Complex point movement. Theorems on the addition of velocities and accelerations in complex motion.
37. Formulate a theorem on the addition of velocities in complex motion. Give formulas. How the modulus of the absolute velocity of a point is determined.
38. Formulate a theorem on the addition of accelerations in complex motion (Coriolis theorem). What is the absolute acceleration of a point in the general case of complex motion?
39. Coriolis acceleration and its properties. How is the magnitude and direction of Coriolis acceleration determined? Explain with an example.

40. Define the spherical motion of the body. Give the equation of spherical motion of the body and analyze it. How many independent quantities are needed to determine the position of a body with one fixed point?
41. Degrees of freedom in spherical motion of the body. Name the angles of Euler, give their characteristic.
42. Formulate the Euler-D'Alembert theorem on the elementary motion of a body with one fixed point. Explain the instantaneous axis of rotation in spherical motion of a body.
43. Describe the angular velocity and acceleration of the body during its spherical motion.
44. Describe the motion of a free solid. How many degrees of freedom does it have? Write the equation of motion of a free solid body and analyze it.
45. Composite motion of a rigid body. Rotational motion of a rigid body around parallel axes. Determination of the absolute angular velocity of rotation.
46. Rotational motion of a rigid body around intersecting axes. Determination of absolute angular velocity and angular acceleration. Explain with an example.
47. Define the center of mass of the system. By what formulas are its coordinates calculated?
48. Explain the essence of the theorem on the motion of the center of mass of a system. What are the consequences of it?
49. The amount of movement of a material point. Momentum of force. Theorem on the change in the amount of motion of a material point in differential and integral form. Explain with an example.
50. The amount of movement of the mechanical system. Theorem on the change in the amount of motion of a mechanical system in differential form and its consequences.
51. Formulate the law of conservation of momentum of a mechanical system. Explain in which problems the law of conservation of momentum of a mechanical system is applied.
52. The kinetic moment of the point relative to the center and axis. Under what conditions are the kinetic moments of the point relative to the center and axis equal to zero?
53. The kinetic moment of a point relative to the center. Theorem on the change of the kinetic moment of a point. How is the directed kinetic moment of the point relative to the center and under what conditions is it equal to zero? Explain with an example.
54. Define the kinetic moment of a point about an axis, give a formula. Under what conditions are the kinetic moments of the point relative to the axis equal to zero?
55. Formulate a theorem on the change of the momentum of a material point relative to the center and its consequences.
56. Define the kinetic moment of the mechanical system relative to the center and axis. Give formulas.
57. Kinetic moment of a mechanical system relative to the center. Theorem on the change of the kinetic moment of a mechanical system and its consequences.
58. Theorem on the change of the kinetic moment of a mechanical system in differential form. Formulate the consequences of this theorem.
59. How to calculate the kinetic moment of the system, which includes a solid body rotating around a fixed axis, and material points. Explain with an example.
60. Method of determining the kinematic characteristics of the system motion using the differential equation of rotation of the body around a fixed axis.
61. Kinetic energy of a homogeneous body and a mechanical system in plane motion (Kenning's theorem).

62. Theorem on the change of kinetic energy of a mechanical system. Analyze individual cases.
63. The work of a constant force applied to the body, performing a plane-parallel motion.
64. Work of constant friction force when sliding the body and when rolling the wheel without slipping. Explain with an example.
65. The operation of a variable force on a rectilinear movement and the operation of a variable torque applied to a rotating body.
66. Principle D' lambe . Determination of inertia forces for different cases of motion of points and bodies. The main force vector and the main moment of inertia of the system.
67. The principle of possible movements. General equation of system dynamics. Equation of motion of the system in generalized coordinates.
68. Lagrange's equation of the second kind and its use to study the motion of a mechanical system.
69. The subject of resistance of materials and its importance in biomedical engineering. Give the main hypotheses in the resistance of materials.
70. Classification of bodies considered in the resistance of materials. The concept of deformation. External and internal power factors.
71. The method of sections and its essence. What internal force factors can occur in the cross sections of the rod in the general case?
72. List the simplest types of deformations of the rods and the conditions of their occurrence. Under what conditions is there tension-compression, displacement, torsion, bending?
73. Define the plot of the internal load. For what purpose is it built? What is called the loading area of the rod when constructing plots? List the external signs of the boundaries of cargo areas.
74. Hooke's law for axial tension-compression. Explain each designation. What properties of the material characterize the Poisson's ratio and Young's modulus?
75. The concept of allowable stresses. Strength condition and types of strength calculations. Give the appropriate formulas for tension-compression.
76. The procedure for calculating statically determined rods for tensile strength.
77. Mechanical stress vector and its components. Explain the concept of "Stress at a point". How to determine the orientation of any area drawn through a given point.
78. Explain the concept of "stress tensor", list its properties. Formulate the law of parity of tangential stresses. How are the components of the stress vector determined?
79. Describe the main platform and main stress. Name the types of stress states depending on the number of principal stresses.
80. Explain the essence of the principle of superposition. What does Hooke's generalized law look like? For what stress state is it used?
81. How are stresses on inclined sections determined? Derive the basic formulas. In which sections the greatest tangential stresses occur.
82. What stress state is called a net shift? Hooke's law for shift. How to determine the potential energy of shear deformation. Give the calculation formulas.
83. What kind of deformation is called torsion? What value is a quantitative characteristic of torsional deformation? Distribution of tangential stresses in the cross section of the shaft.
84. Give the calculation formulas for tensile strength and rigidity. How to check the shear strength. Explain with an example.

85. Define bending deformation. Name the types of bending. What are the differences between clean, flat and transverse bending? Explain with an example.
86. Derive the differential relationships between the intensity of the distributed load, the transverse force and the bending moment.
87. Analyze the differential relationships between the intensity of the distributed load, the transverse force and the bending moment.
88. List the basic patterns in the construction of diagrams of longitudinal forces.
89. Give an algorithm for plotting the characteristic cross sections. Formulate the rules of signs to determine the bending moment and transverse force.
90. The sequence of construction of plots of internal force factors for rod systems during tension-compression.
91. Normal stresses at pure bending. Hooke's law. Basic formulas.
92. Give the basic formulas for calculations of flexural strength. Calculation of the strength of the rods in pure bending.

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[1] The syllabus template was approved by the methodological council of the university