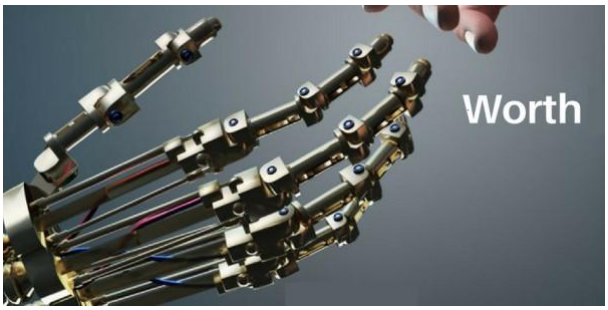
Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Applied Radio Electronics

[RE-33] APPLIED MECHANICS



Curriculum of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	17 - Electronics, automation, and electronic communications
Specialization	172 - Electronic Communications and Radio Engineering
Educational program	All educational programs
Discipline status	Elective (F-catalog)
Form of higher education	Full-time
Year of training, semester	Available for selection starting from the 2nd year, spring semester
Scope of the discipline	4 credits (Lectures 18 hours, Practical classes 36 hours, Laboratory work 36 hours, Independent work 66 hours)
Semester Control/control measures	Credit
Class schedule	https://rozklad.kpi.ua
Language of instruction	Ukrainian
Information about the course coordinator/teacher s	Lecturer: Shulga A. V., Lab: Shulga A. V., Independent work: Shulga A. V.
Course location	https://do.ipo.kpi.ua/course/view.php?id=991

Curriculum

1. Description of the course, its purpose, subject matter, and learning outcomes

The Applied Mechanics course provides bachelor's students with thorough training in researching and creating mechanical systems, making informed choices about materials and component shapes, and designing and reliably operating machines that are typical for the relevant industry. By studying this course, students will not only learn the theoretical foundations of the construction, structure, kinematics, and dynamics of mechanisms, mechanical transmissions, the principles and basics of design and verification calculations for machine parts and assemblies, and approaches to ensuring their interchangeability, but will also be able to perform calculations of structural elements for strength, rigidity, and stability; perform design and verification calculations of parts and assemblies of structural elements, mechanisms, and machines, as well as use ways and methods

to ensure their interchangeability.

The aim of the course is to train broadly-based bachelors who combine deep fundamental knowledge with thorough practical training focused on application in professional activity.

As a result of studying the discipline, students should *know*: types of supports, types of calculations, kinematic characteristics of motion, criteria for machine performance. Be able to: draw up calculation diagrams and perform calculations for strength, rigidity, and stability of structural elements.

The discipline provides the formation of the following competencies:

- The ability to perform computer modeling of devices, systems, and processes using universal application software packages (PC 4);
- Ability to implement promising technologies and standards (PC 8);
- Ability to select and apply specialized software tools for simulation modeling and design of radio-electronic equipment (PC 23)

Program learning outcomes:

- Explain the results obtained from measurements in terms of their significance and relate them to the relevant theory (PLO 04);
- Explain the principles of construction and operation of hardware and software complexes of control and maintenance systems for the development, analysis, and operation of information and telecommunications networks, telecommunications, and radio engineering systems (PLO 20);
- Design and implement elements of intelligent technologies using software-configurable equipment (PLO 26)

2. Prerequisites and post-requisites of the discipline (place in the structural-logical scheme of training under the relevant educational program)

Prerequisites for mastering the introductory discipline:

students must *be familiar with:* higher mathematics, computer science, engineering and computer graphics, fundamentals of metrology, introduction to the specialty, and preferably three-dimensional modeling of radio-electronic equipment.

3. Course content

Topic 1. Theory of mechanisms

1.1. Structure of flat mechanisms

1.2. Kinematics of mechanisms

1.2.1. Basic tasks of kinematic research 1.2.2.

Construction of mechanism position plans

1.3. Dynamic study of mechanisms

1.3.1. Kinostatic study of mechanisms

1.3.2. Determination of Fpr using Zhukovsky's lever Topic 2.

Strength of materials

2.1. Types of deformation

2.1.1. Tension-compression

2.1.2. Shear and crushing

2.1.3. Torsion

2.1.4. Bending

2.2. Elastic line of a beam. Determination of displacements

2.3. Longitudinal bending. Stability of

compressed rods Topic 3. Transmissions

3.1. Determination of the main characteristics of transmission

3.2. Mechanical transmissions

3.3. Gear transmissions

3.4. Straight-tooth cylindrical transmissions

3.5. Helical cylindrical gears

3.6. Bevel gear transmissions

3.7. Worm gears

3.8. Planetary gearboxes

3.9. Gearboxes

3.10. Belt drives

3.11. Shafts and axles

3.12. Bearings

3.13. Couplings

3.14. Threaded connections

3.15. Keyed joints

3.16. Splined (toothed) joints

3.17. Rivet connections

3.18. Welded joints

4. Training materials and resources

Basic literature

1. Petrik V. O. Applied Mechanics / V. O. Petrik, S. I. Trubachev, V. A. Kolodezhnij – Kyiv: NTUU "KPI", 2022. – 295 p.

2. Borozents, G. M. Applied Mechanics and Fundamentals of Design: Textbook. / G. M. Borozents, V. M. Pavlov, O. V. Golubnichiy [et al.]. — Kyiv: NAU, 2015. — 356 p. ISBN 978–966–598–843-4

3. Pysarenko, G. S. Strength of Materials / G. S. Pysarenko, O. L. Kvitka, E. S. Umansky; edited by G. S. Pysarenko. — Kyiv: Vyshcha Shkola, 2004. — 655 p.

4. Pavlishche, V. T. Fundamentals of Design and Calculation of Machine Parts. Lviv: Afisha, 2003. 560 p.

Supplementary

1. Petrik V. O. Applied Mechanics: Methodological Guidelines for Practical Classes / Compiled by V. O. Petrik, O. V. Tymoshenko. – Kyiv: NTUU "KPI", 2010. – 116 p.

2. Dovbush A.D. Applied Mechanics and Fundamentals of Design: Teaching Manual for Calculation and Graphic Work / A.D. Dovbush, N.I. Khomik, T.A. Dovbush, N.A. Rubinet. – Ternopil: FOP Palianytsia V.A., 2015. – 116 p.

Information resources

https://www.solidworks.com

https://edu.3ds.com/en/get-

software

Educational content

5. Methodology for mastering the academic discipline (educational component)

Lectures

No No	Lecture topic and list of key questions (list of teaching aids, references to literature, and assignments for independent study)
1	*Introduction.* *Topic: "Theory of mechanisms"* • *Structure of flat mechanisms* • *Kinematics of mechanisms* • *Main tasks of kinematic research* *Construction of mechanism position plans* *Literature:* 1, 2 sources from the list of educational materials *Assignments for independent study:* • Review lecture materials
2	*Topic: "Theory of mechanisms"* • *Dynamic study of mechanisms* • *Kinostatic study of mechanisms* *Determination of Fpr using Zhukovsky's lever Literature:* 1, 2 sources from the list of educational materials *Assignments for independent study:* Review lecture materials
3	*Topic: "Strength of Materials"* • *Types of deformation* *Tension-* *compression* *Literature:* 1, 3 sources from the list of educational materials *Assignments for independent study:* Review lecture materials
4	*Topic: "Strength of Materials"* • *Shear and crushing* • *Torsion* *Bending* *References:* 1, 3 sources from the list of educational materials *Assignments for independent study:* Review lecture materials

5	*Topic: "Strength of Materials"* • *Elastic line of a beam. Determination of displacements* *Longitudinal bending. Stability of compressed rods.* *References:* 1-3 sources from the list of educational materials *Assignments for independent study:* Review lecture materials
6	*Topic: "Transmissions"* • *Defining the main characteristics of transmission* • *Mechanical transmissions* • *Gear transmissions* • *Spur gears Literature:* 1-4 sources from the list of educational materials *Assignments for independent study:* Review lecture materials
7	*Topic: "Gears"* • *Helical cylindrical gears* • *Bevel gears* • *Worm gears* *Planetary gear transmissions* *Literature:* 1-4 sources from the list of educational materials *Assignments for independent study:* Review lecture materials
8	*Topic: "Transmissions"* • *Gearboxes* • *Belt transmissions* • *Shafts and axles* *Bearings* *Literature:* 1-4 sources from the list of educational materials *Assignments for independent study:* Review lecture materials
9	*Topic: "Connections"* • *Couplings* • *Threaded connections* • *Keyed joints* • *Splined (toothed) connections* • *Rivet joints* *Welded joints* *Literature:* 1-4 sources from the list of educational materials *Assignments for independent study:* Review lecture materials

Laboratory work

No	Name of laboratory work
1	Determination of deformation, stress, and displacement of a cantilever beam in SolidWorks environment
2	Gear transmissions
3	Determination of elastic properties and characteristics of coil springs
4	Calculation of different types of transmissions

6. Independent work by students

Planned homework assignment, in which it is necessary to draw up a calculation diagram and perform calculations for the strength, rigidity, and stability of structural elements.

Policy and control

7. Policy of the academic discipline (educational component)

Rules for attending classes (both lectures and labs)

Attendance and completion of laboratory work are mandatory. If you miss these classes, you must make them up during consultations or with other groups, if available. If you miss lectures, you must study the material on your own. Lecture materials are posted on the Sikorsky platform.

Defense of laboratory work

Laboratory work is defended at the beginning of the next class. Students receive two grades. The first is for the correctness of the results obtained and the completion of the protocol. The second is for the defense (passing the test on the Sikorsky platform).

Defense of homework assignments

Homework assignments are completed independently by each student. Students receive two grades. The first is for the correctness of the work and its presentation. The second is for the defense (passing the test on the Sikorsky platform).

Modular test

Modular test work is performed by each student independently after completing the entire lecture course. The student receives a grade after passing the test on the Sikorsky platform.

Incentive and penalty points and academic integrity policy

The most active students and students who complete individual assignments in an exemplary manner can receive up to 10 points towards their semester rating.

Penalty points are applied in cases of passing off someone else's work as one's own, with mandatory subsequent reworking.

Deadline and resit policy

If the deadlines for submitting assignments are missed, the maximum score for the assignments is reduced by 10%.

8. Types of assessment and the learning outcomes assessment rating system (LOAS)

The curriculum for the RE-33 course provides for the following rating system:

- Lectures - 18 hours;
- Module Control Work x *15 points*;
- Laboratory work - 36 hours; (4 *labs x 15 points*)
- Home Control Work (*1 assignment x 25 points*)

Table of correspondence between rating points and grades on the university scale

Number of points	Grade
100-95	Excellent
94	Very good
84	Good
74-65	Satisfactory
64-60	Sufficient
Less than 60	Unsatisfactory
Conditions for admission not met	Not admitted

9. Additional information on the discipline (educational component)

List of questions for semester assessment:

1. How to determine the class and order of a mechanism?
2. What is the difference between the kinematic and structural diagrams of a mechanism?
3. What does the degree of freedom of a mechanism show and how can it be determined?
4. What are the tasks and order of performing a structural analysis of a mechanism?
5. What is the relationship between the absolute, relative, and transfer speeds of a point?
6. What is the velocity diagram of a mechanism and how is it constructed?
7. What is the relationship between the absolute, relative, translational, and Coriolis accelerations of a point?
8. What is the acceleration diagram of a mechanism, and how is it constructed?
9. How to determine the magnitude and direction of angular velocity and acceleration?
10. What is D'Alembert's principle and where is it applied in the theory of mechanisms?
11. What problems can be solved by studying a mechanism using the kinostatic method?
12. What is the difference between reduced and balancing forces?
13. What is a Zhukovsky lever and where is it applied in mechanism theory?
14. What is the calculation of a part's strength, rigidity, and stability?
15. What is a verification calculation in strength of materials?
16. What is design calculation in structural analysis and what types are there?
17. What are the simple types of deformation?
18. What are the rules for constructing diagrams of internal longitudinal forces and torsional moments?
19. What are the rules for constructing and verifying diagrams of internal transverse forces and bending moments?
20. What is permissible stress?
21. What are the conditions for tensile (compressive), shear, and bending strength?
22. What are the conditions for shear and torsion strength?
23. Where are the principal central axes of a cross-section applied and how are they found?
24. What is the procedure for calculating the principal central moments of inertia of a complex cross- section?
25. How are the displacements of cross sections determined using the initial parameters method?
26. What is the relationship between permissible stresses for stability and compression?
27. What is the procedure for designing a compressed rod for stability?
28. What are the types of transmissions and their characteristics?
29. What is the efficiency coefficient (EC) of a transmission?
30. How is the transmission ratio of a transmission and drive determined?
31. What parameters are used to select an electric motor for a drive?
32. What are the main and additional characteristics of belt and gear drives?
33. What is a gear module?
34. What are the main types of heat treatment used in gear transmissions?
35. What are planetary and differential gears, and what are their features and applications?
36. What elements make up a planetary gear?
37. What is the water stop method and what is it used for?
38. What is the procedure for selecting rolling bearings?
39. What is a shaft system?

Description of material, technical, and informational support for the discipline

The Applied Mechanics course is fully equipped with lecture halls featuring modern technology for conducting lectures in the form of presentations, as well as computer classrooms for practical and laboratory classes, which have the necessary software, namely SolidWorks and Fluid SIM. The course also features models that help students understand the principles of applied mechanics through visual examples.

The working program of the academic discipline (syllabus):
Compiled by Shulga A. V.;
Approved by the PRE Department (Minutes No. 06/2024 dated 06/27/2024)
Approved by the methodological commission of the faculty/research institute (protocol No. 06/2024 dated 06/28/2024)