COURSE DESCRIPTION CARD - SYLLABUS

Course name
Strength analysis of mechanical structures [S2MiBM2>AWKM]

Course

Field of study
Mechanical Engineering

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

A student has basic knowledge about mathematics, strength of materials, engineering graphics and other areas of studies. A student has theoretical knowledge of areas of studies. A student can solve basic problems of geometry and mathematical analysis. A student can solve basic problems of solid mechanics. A student can search for necessary information and facts in literature, scientific databases and catalogues. A student can use information and communication techniques for realizing engineering tasks. A student has the ability to self-study. A student understands a need for lifelong learning and acquiring knowledge. A student understands general social results of engineering activities. A student understands a need for teamwork. A student is aware of connections between mathematics, physics and technical sciences.

Course objective

To learn theoretical and practical problems related to endurance analysis based on the mechanical properties of materials as the basis for proper design of different constructions. Acquaintance with advanced issues of strength of materials in theoretical terms and practical applications, including: stability of bar systems, beams on elastic substrate and Clapeyron’s systems. Delivering in understandable form selected endurance issues using energy methods, ie reciprocal-work theory and reciprocal-displacement theory, Castigliano's theories and Castigliano-Menabre's least work, Maxwell- Mohr's methods and forces. Strength calculations of frames and arcs by displacement and force method. Transmission of selected computational issues from the strength of materials construction elements under the influence of basic loads and complex loads. Design of technological connections and analysis of deformation and displacement in various types of structures or parts of structures such as rods, shafts, beams and flat frames. Experimental research in strength analysis of mechanical structures. Numerical testing in strength analysis of mechanical structures.

Course-related learning outcomes

Knowledge:
1. The graduate has extended and deepened knowledge in the field of mathematics and has structured, theoretically based general knowledge in the field of analytical mechanics.
2. The graduate has extended and deepened knowledge of the strength of materials and understands the basic models and computational methods used in construction.
3. The graduate has knowledge of the theory of elasticity and plasticity, knows the basics of the theory of elasticity and plasticity. Knows what phenomena in nature and technology relate to the theory of elasticity and plasticity.
4. The graduate has knowledge in the field of modeling supporting machine design, including simplifying assumptions used in modeling and creating a physical model of a mechanical system.

Skills:
1. The graduate is able to obtain information from literature, databases and other properly selected sources, also in English or another foreign language, is able to integrate the information obtained, interpret and critically evaluate it, as well as draw conclusions and formulate and fully justify opinions.
2. Is able to work individually and in a team, is able to use information and communication techniques appropriate to carry out tasks, is able to prepare a study in Polish presenting the results of his own scientific research; can prepare and present an oral presentation on detailed issues in the field of mechanics and machine construction
3. Is able to formulate criteria for selecting an appropriate mathematical method to solve a given technical problem. Is able to use selected mathematical methods to solve a technical problem.
4. Is able to perform strength analyzes of machine elements and mechanical systems using basic methods of advanced structure strength analysis, stability, and energy methods in structure strength analysis.
5. Is able to apply the basic laws of analytical mechanics and simplified models in solving simple problems in the field of mechanics and machine construction, and select modeling methods in design, and perform basic calculations in modeling.
6. Is able to plan and carry out experiments. Able to work in an industrial environment and knows basic occupational health and safety rules.
7. Is able to use IT systems in the design of machines and technological processes relevant to mechanics and machine construction. Is able to use CAx systems to design machines and simulate engineering issues.

Social competences:
1. Is well aware of the necessity for continuous learning; knows how to inspire and organize the process of learning of other people.
2. Is aware of the importance and understanding of non-technical aspects and results of engineering activities including its influence on the environment involving responsibility for decisions taken.
3. Knows how to cooperate and work in teams assuming various roles within.
4. Knows how to prioritize steps in order to carry out a task either defined by him/herself or by others.
5. Is able to determine the importance of knowledge in solving cognitive and practical problems and to seek the opinion of experts in case of difficulties in solving the problem independently.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written and oral examination (3 computational tasks and 5 theoretical questions + conversation with the teacher lecture on the issues of strength II)
- <50% - ndst, >51-60% - dst, >61-70% - dst plus, >71-80% - db, >81-90% - db plus, >91% - bdb
Assessment of tutorials (There are three tests in a semester and offer solutions to the exercises questions prepared by the teacher training):
- <50% - ndst, >51-60% - dst, >61-70% - dst plus, >71-80% - db, >81-90% - db plus, >91% - bdb
Self-semester work.
Assessment: activity at lectures and accounting exercises.In order to receive a positive grade and pass the course a student needs to achieve more than 50% of total points in each test. The final grade is based on the following rules:
very good - if the ratio of sums of achieved and total points is bigger than 91%,
good plus - if the ratio of sums of achieved and total points is between 81-90%,
good - if the ratio of sums of achieved and total points is between 71-80%,
sufficient plus - if the ratio of sums of achieved and total points is between 61-70%,
sufficient - if the ratio of sums of achieved and total points is between 51-60%.

Programme content

Beams on elastic foundations. Compression of bending beams. Loss of stability of compression rods: buckling in the elastic and elastic-plastic range. Generalized forces and generalized displacements. Energy methods. Castigliano’s theorem and Castigliano-Menabre the principle of minimum strain energy. Use of these methods to calculate the displacement of bar structures. Experimental research in strength analysis of mechanical structures. Numerical testing in strength analysis of mechanical structures.

Course topics

Lectures and tutorials
Beams on elastic foundations, the differential equation of the deflection of the beam, the boundary conditions and expected solution. Compression of bending beams. Loss of stability of compression rods: buckling in the elastic and elastic-plastic range. Generalized forces and generalized displacements. Clapeyron’s systems. Energy methods. Displacement and susceptible description of deformation of elastic structures. Betty's reciprocal-work theorem and Maxwell's reciprocal-displacement theorem. Examples of computing. Castigliano’s theorem and Castigliano-Menabre the principle of minimum strain energy. Use of these methods to calculate the displacement of bar structures. The Maxwell-Mohr method of displacement calculation. The canonical equations of force method, force method. Strength calculations of frames and arcs by displacement and force method. Experimental research in strength analysis of mechanical structures. Numerical testing in strength analysis of mechanical structures.

Teaching methods

1. Lecture: presentation illustrated with examples administered on the blackboard, solving tasks.
2. Exercises: solving tasks on the board (problem solving), discussion.

Bibliography

Basic:
1. Zielnica J., Wytrzymałość Materiałów, WPP 1996.
2. Ostwald M., Podstawy wytrzymałości materiałów, Wydawnictwo PP, Poznań, 2007.
3. Magnucki K., Szyc W., Wytrzymałość materiałów w zadaniach: pręty, płyty i powłoki obrotowe, Wydawnictwo Naukowe PWN, 2000.
4. Leyko J., Mechanika ogólna t.1, PWN, Warszawa, 1997

Additional:
1. Banasik M., Grossman K., Trombski M., Zbiór zadań z wytrzymałości materiałów. PWN 1992.
2. Osiński Z., Mechanika ogólna, PWN, Warszawa, 1994.
3. Ostwald M., Wytrzymałość materiałów. Zbiór zadań. Wydawnictwo PP, Poznań, 2008.
4. Dyląg Z., Jakubowicz A., Orłoś Z., Wytrzymałość materiałów t.1 i 2, WNT, Warszawa, 2000.
5. European and Polish Standards.
6. Niezgodziński M. E., Niezgodziński T., Wzory, wykresy i tablice wytrzymałościowe, Wydawnictwo Naukowo-Techniczne Warszawa 2004.

7. Willems N., Easley T. J., Rolfe S. T., Strength of Materials, Mc GrawHill Book Company, 1981.
8. Gere M., Timoshenko S., Mechanics of Materials, PWS-Kent Publishing Company, Boston, 1984.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	47	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	28	1,00