COURSE DESCRIPTION CARD - SYLLABUS

Course name
Computer design of thin-walled structures

Course

Field of study
Mechanical Engineering
Area of study (specialization)
-
Level of study
First-cycle studies
Form of study
full-time

Year/Semester
3/6
Profile of study
general academic
Course offered in
polish
Requirements
elective

Number of hours

Lecture
15
Laboratory classes
15
Other (e.g. online)

Tutorials
Projects/seminars

Number of credit points

3

Lecturers

Responsible for the course/lecturer:
Piotr Kędzia, PhD
email: piotr.kedzia@put.poznan.pl
tel. 61 665 20 64
Faculty of Mechanical Engineering
ul. Jana Pawła II 24, 61-131 Poznań

Responsible for the course/lecturer:

Prerequisites

Basic knowledge of mathematics and other areas of education in the field of study. Knowledge of the strength of materials. Ability to solve problems in statics. Ability to solve tasks in mathematics: algebra, mathematical analysis, geometry. The ability to search for necessary information in literature,

databases, on the Internet and in indicated sources. Ability to self-study and self-education. Using information and communication techniques appropriate to the implementation of engineering tasks.

Course objective

Provide basic knowledge on the determination of stresses and strains in thin-walled structures, such as beams and shells. Presentation in a concise and understandable form of the basics of stability necessary in the design of safe and reliable structures. Overview of basic models and calculation methods, paying attention to the importance of formulating stability conditions. Indication of the possibilities of solving stability problems by various methods. Acquainting with the finite element method in the field of modelling and analysis of thin-walled structures. Drawing attention to the threats to the safe operation of machines resulting from the loss of stability of their parts or their assemblies. Realizing the complexity of the problems, distinguishing various forms of loss of stability.

Course-related learning outcomes

Knowledge

1. Knowledge and understanding of the phenomenon of loss of stability of systems, including structures.
2. Has the knowledge of geometrical properties of thin-walled beams with open cross-section including warping function, shear center and warping constant.
3. Know and understand the methods for determining normal and shear stress in thin-walled beams with open cross-sections.
4. Has the knowledge of determining the internal forces and moments as well as the stress in thin shells.
5. Understanding the basic models and calculation methods necessary in the study of structural stability.
6. Awareness of the importance of stability in the design of safe and reliable structures.
7. Knowledge of the basic concepts of structural stability.
8. Understanding the importance of theories and experiments in the study of structural stability.
9. Knowledge of current issues in world research.

Skills

1. 1. Formulating and solving simple problems of structure stability under static loads.
2. Formulation of stability conditions for simple structures.
3. Determination of critical loads for selected structures.
4. Identification of the technical problem - indication of the stability problem.
5. Ability to define and characterize thin-walled structure.
6. Ability to conduct basic strength calculations of simple thin-walled structures with the use of analytical approach.
7. Ability to prepare the FE model of a thin-walled structure and conduct strength static calculations.

Social competences

1. Understanding the need for self-education related to the development of technology.
2. Awareness of the importance of engineering activities.
3. The ability to make the right decisions and make the right decisions for the problem.
4. Understand the importance of teamwork.
5. Understand the meaning of computer systems in design and analysis of thin-walled structures.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Passing the lecture: test during the last class in the semester:
rating 3.0 50.1% -60%
rating 3.5 60.1% -70%
rating 4.0 70.1% -80%
rating 4.5 80.1% -90%
rating 5.0 90.1% -100%

Passing the labolatory: current verification of the learning results and the final test at the last class in the semester:
rating 3.0 50.1% -60%
rating 3.5 60.1% -70%
rating 4.0 70.1% -80%
rating 4.5 80.1% -90%
rating 5.0 90.1% -100%

Assessment of activity during lectures and involvement in classes included in the final grades.

Programme content

1. Introduction
- presentation of basic properties of thin-walled structures
- presentation of examples of applications of thin-walled structures
- introducing computational methods

2. Thin-walled bars
- geometrical properties of thin-walled bars with open cross-sections, warping function, warping constant, internal forces, bimoment
- equation of the angle of twist of thin-walled bar
- shear and normal stress in free torsion

3. Bars and bar systems
- stability of bars in compression or bar systems
- loss of stability of a rigid column supported by a bar,
- buckling of compressed beams with different edge support methods, buckling of multi-span beams, buckling of beams on an elastic foundation,
- buckling of a flat frame

4. Plate stability
-stability of rectangular plates
- stability of circular plates

5. Thin-walled shells of revolution
- geometrical description of shells

- presentation of the membrane state of stress
- determining stress in shells of revolution
- stability of shells of revolution

6. Application of the finite element method in the analysis of thin-walled structures
- the rules of modelling of thin-walled beam and shells - selection of the finite element and the boundary conditions
- analysis of typical load cases.

Teaching methods

Lecture:
- lecture with multimedia presentation containing figures and pictures supported with examples presented on the blackboard
- application of theoretical knowledge presented on the lecture to solve simple engineering problems
- during the lecture the discussion with students is initiated

Laboratory:
- modelling and solving engineering problems with the use of a computer system based on the finite element method

Bibliography

Basic

1. Magnucki K., Stawecki W., Lewiński J. Modelowanie analityczne i numeryczne podstawowych części konstrukcji pojazdów szynowych, Instytut Pojazdów Szynowych TABOR, Poznań 2021.
2. Magnucki K., Szyc W. Wytrzymałość materiałów w zadaniach. Pręty, płyty i powłoki obrotowe. Wyd. naukowe PWN, Warszawa, 2000.
3. Magnucki K., Stawecki W. Stateczność wynranych części konstrukcji, Instytut Pojazdów Szynowych TABOR, Poznań 2016.
4. Weiss S., Giżejowski M. Stateczność konstrukcji metalowych. Arkady, Warszawa, 1991.
5. Życzkowski M. Stateczność prętów i ustrojów prętowych, s.242-380. M. Życzkowski (red.) Mechanika techniczna. Wytrzymałość elementów konstrukcyjnych. T.IX, PWN, Warszawa, 1988.

Additional

1. Baľant Z.P., Cedolin L. Stability of structures. Oxford University Press, New York, Oxford,1991.
2. Doyle J.F. Nonlinear analysis of thin-walled structures. Springer Verlag, New York, 2001.
3. Demidowicz B.P. Matematyczna teoria stabilności. Wyd. Naukowo-Techniczne, Warszawa 1972.
4. Murray N.W. Introduction to the Theory of Thin-Walled Structures, Clarendon Press, Oxford 1986.
5. Vlasov V.Z. Thin-Walled Elastic Beams, National Science Foundation, Washington, D.C. 1961

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,0
Classes requiring direct contact with the teacher	40	1,5
Student's own work (literature studies, preparation for laboratory, preparation for tests) [1]	35	1,5

[1] delete or add other activities as appropriate