COURSE DESCRIPTION CARD - SYLLABUS

Course name

Mechanics of composites with optimization

Course

Field of study	Year/Semester
Mechanical engineering	2
Area of study (specialization)	Profile of study
FEM in mechanics	general academic
Level of study	Course offered in
Second-cycle studies	polish
Form of study	Requirements
full-time	elective

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
15	15	
Tutorials	Projects/seminars	

Number of credit points

2

Lecturers

Responsible for the course/lecturer:

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Faculty of Mechanical Engineering

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Responsible for the course/lecturer:

Prerequisites

1. Basic knowledge of mathematics, mechanics and strength of materials corresponding to the core curriculum for the first-cycle studies.

2. The ability to think logically and the skill at searching needed information from various sources.

3. The awareness of the necessity for continuous learning and improving the skills.

Course objective

1. Getting to know the basic information about the structure and the mechanical properties of composites and biocomposites and the methods of their examination.

2. The ability to apply the acquired knowledge to modeling the mechanical properties of composite materials and biocomposites.

Course-related learning outcomes

Knowledge

1. The student who completed the course can define the composite materials, name the basic kinds of composite materials, describe their structure and discuss their applications particularly in medicine and prosthetics.

2. The student knows the factors determining the mechanical properties of composite materials and can discuss, using the methods of micromechanics of materials, how the mechanical features of composites depend on the properties of their components and the local conditions.

3. He can discuss and interpret the constitutive stress-strain relations for a thin unidirectional lamina in principal axes and also in any direction.

4. He can present the basic assumptions, concepts and methods of the lamination theory of composite materials.

5. He knows and can present the basic experimental methods employed in examination of composite materials.

Skills

1. The student can determine the mechanical properties of the composite material knowing the properties of their components and the local conditions.

2. He can describe and interpret the anisotropic mechanical properties of the composites and biocomposites.

3. He can determine the extensional, bending and coupling stiffness matrices for multidirectional laminates.

Social competences

1. By preparing the projects, the student learns himself to cooperate within a team and be responsible for the tasks entrusted to him.

2. He understands the importance of knowledge in the modern world. He is also well aware that the rapid development of knowledge causes the need for lifelong learning.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures

Credit in the form of a written test, which consists of questions, theoretical issues and elementary practical tasks related to the lectures contents. Passing requires obtaining at least 50% of the total points; the grading scale is linear.

Laboratory classes

Assessment of the activity in solving tasks at classes and assessment of the projects done in small groups. Passing for a positive grade requires collecting at least 50% of the total points; linear grading scale.

Programme content

Lectures

Definition of composite materials and some basic information related them. Structure of composite materials. Composite materials classification. The use of composite materials. Unidirectional continuous fiber composites. Micromechanics of fiber composites and its methods. Mechanics of materials - composite material models and prediction of their mechanical properties in dependence of the component properties and the local conditions. Multidirectional continuous fiber composite (laminates) - their structure, denotation system and fabrication technology. Laminate composite materials analysis in various spatial scales. Anisotropy of mechanical properties - general case, orthotropic material, transversely isotropic material. The constitutive stress-strain relations for a thin unidirectional lamina in the principal axes. The constitutive stress-strain relations for a thin unidirectional lamina in any direction. The constitutive stress-strain relations in the Voigt notation. Stiffness and compliance matrices in engineering constants. Stress and strain state analysis in the non-axial configuration. Plane stress state. Elements of the lamination theory of composite materials - the extensional, bending and coupling stiffness matrices for multidirectional laminates. Experimental methods of testing composite materials. Optimization problems in mechanics of composites - optimization criteria, objective functions, decision variables, constraints.

Laboratory classes

Vector and tensor coordinates (of the second and the fourth rank) transformation rules within Cartesian coordinate systems. Examination of the mechanical properties of the fiber composites as functions of the properties of their components and the local conditions. The constitutive stress-strain relations for general isotropic and orthotropic materials. The constitutive stress-strain relationships for a thin lamina in the principal axes and in the non-axial configuration. Determination of the extensional, bending and coupling stiffness matrices for multidirectional laminates. Determination of the mechanical properties of selected laminates - design task in groups. Selected problems of the load state analysis of structural elements made of composite materials - modeling, solutions, discussion. Optimization problem concerning the design of a laminate composite structure - design task.

Teaching methods

Lectures: lecture supported by multimedia presentations, solving tasks at the blackboard; discussion. The online course is available on the Moodle platform, which includes the presentations from lectures, proposals for tasks for independent work and issues to help students prepare for the tests.

Laboratory classes: problem solving with the use of Mathematica and a software package for FEM, results discussion. Design tasks preparation in small groups.

Bibliography

Basic

1. J. German, Podstawy mechaniki kompozytów włóknistych, Wydawnictwo Politechniki Krakowskiej, 2001.

2. Mechanika techniczna, t. XII Biomechanika, pod red. R. Będzińskiego, IPPT PAN, Warszawa 2011.

3. K. K. Chawla, Composite Materials. Science and Engineering, Springer Verlag, 1987.

4. I. M. Daniel, O. Ishai, Engineering Mechanics of Composite Materials, Oxford University Press, 1994.

Additional

1. F. M. Capaldi, Continuum mechanics. Constitutive Modeling of Structural and Biological Materials, Cambridge University Press.

2. S. Ochelski, Metody doświadczalne mechaniki kompozytów konstrukcyjnych, WNT, Warszawa 2004.

3. M. Ostwald, Podstawy optymalizacji konstrukcji. Wydawnictwo Politechniki Poznańskiej.

4. http://www.kompozyty.ptmk.net/archiwum.html

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	2,0
Classes requiring direct contact with the teacher	35	1,0
Student's own work (literature studies, preparation for laboratory classes, final elaboration of the results obtained at laboratory classes, work at the design projects, self-study with the employing of the online course, preparation for test) [1]	40	1,0

[1] delete or add other activities as appropriate