COURSE DESCRIPTION CARD - SYLLABUS

Course name
Mechanics of composites and biocomposites [S2IBio1-IIiP>MKiB]

Course

Field of study
Biomedical Engineering

Year/Semester
2/3

Area of study (specialization)
Engineering of Implants and Prosthesis

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

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:

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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

Definition and classification of composite materials.
Structure of composite materials.
Biocomposites.
Mechanical properties of composite materials.
Experimental methods of testing composite materials and biocomposites. Application of composite materials in medicine and prosthetics.

Course topics

Lectures:
Basic knowledge about composite materials.
Definition of a composite material.
Structure of composite materials.
Composite materials classification.
Biocomposites.
Application of composite materials.
Composite materials in medicine and prosthetics.
Unidirectional continuous fibre composites.
Micromechanics of fibre composites and its methods.
Mechanics of materials - composite material models and prediction of their mechanical properties in dependence on the component properties and the local conditions.
Multidirectional continuous fibre 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 and biocomposites.

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 fibre 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 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 - modelling, solutions, discussion.

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

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00