Course description

Department/Unit /	KME / MKM1			**Academic Year**	2023/2024
Title	Mechanics of composite materials 1			**Type of completion**	Exam
Accredited/Credits	Yes, 5 Cred.			**Type of completion**	Combined
Number of hours	Lecture 2 [Hours/Week] Tutorial 2 [Hours/Week]				
Occ/max	Status A	Status B	Status C	**Course credit prior to**	YES
Summer semester	3 / -	14 / -	1 / -	**Counted into average**	YES
Winter semester	0 / -	0 / -	0 / -	**Min. (B+C) students**	10
Timetable	Yes			**Repeated registration**	NO
Language of instruction	Czech, English			**Semester taught**	Summer semester
Optional course	Yes			**Internship duration**	0
Evaluation scale	1|2|3|4			**Ev. sc. – cred.**	S|N
No. of hours of on-premise					
Auto acc. of credit	Yes in the case of a previous evaluation 4 nebo nic.				
Periodicity	K				
Substituted course	KME/MKM				
Preclusive courses	N/A				
Prerequisite courses	N/A				
Informally recommended courses	N/A				
Courses depending on this Course	KME/SZMPT				

Course objectives:

The course is focused on mechanical properties of composite materials. The basic terms for elastic materials are introduced, such as stress and strain, Hooke's Law and classification of anisotropic materials. The focus is given to unidirectional composites - laminate. Relations for off-axis stiffness and compliance and off-axis elasticity constants are derived. The summary of macromechanical failure criteria for unidirectional composites is given. Special attention is paid to analysis of laminates. It is shown how the laminate lay-up influences the mechanical properties of the laminate, stresses caused by temperature change or by moisture absorption. Analysis of thin-walled tubes prepared by filament winding is presented. The laboratory classes will include the solution both analytically and numerically and using modern computational methods. Portion of the classes will take place in computational labs where numerical simulations of mechanical behaviour of composite materials will be performed.

Requirements on student

Requirements for course acknowledgement:
Submission of semester work.

Requirements for exam:
Active knowledge of lectured and exercised subject matter and the ability to apply it in the solution of specific problems

Content

1.Motivation lecture. Intoduction in FEM. Basic terms.
(Review of contemporary computaional systems for composite structures design and optimization.)
2.Production and technology (unidirectional composites, composites with textile reinforcement, sandwiches, etc.)
(Basic terms of mechanics of materials)
3.Basic relations of mechanics of anisotropic materials (stress and strain tensors), classification of anisotropic materials.
(Use of MATLAB code for mechanics of materials problems)
4.Unidirectional composites, stress to strain relation. Stress and strain transformation.
(Stiffness matrice of orthotropic material computation.)¨
5.Elasticity constants of unidirectional composites and textile reinforced composites.

(Computation of off-axis stiffness matrix elements, deformations of a curved beam from unidirectional composite)
6.Experimental determination of material characteristics of composites.
(Minimizing curved beam deflection subjected to a concentrated load. Electric resistance strain gauges.)
7.Composite material failure. Fracture processes and micromechanical failure criteria.
(Labs - unidirectional composite tensile test.)
8.Composite material failure criteria - non-interactice and interactive ones.
(Laboratory measurement evaluation, ways of determining elastic constants of a unidirectional composite.)
9.Laminate analysis, classical laminate theory.
(Failure index computation using different criteria.)
10.Constitutive relations, lay-up sequence of laminate.
(Computation of extensional, bending and coupling stiffness matrices.)
11.Stress in laminate caused by change in temperature and moisture. Thin-walled tubes made by winding, axial stiffness.
(Analysis of the influence of laminate lay-up sequence.)
12.New trends in manifacturing structures from composite materials.
(Computation of an axial stiffness of a thin-walled tube made by winding.)
13.Reserve.
(Credit awarding.)

Fields of study

Guarantors and lecturers

- **Guarantors:** Prof. Ing. Vladislav Laš, CSc. (100%)
- **Lecturer:** Prof. Ing. Vladislav Laš, CSc. (100%)
- **Tutorial lecturer:** Ing. Martin Zajíček, Ph.D. (100%)

Literature

- **Basic:** Laš, Vladislav. *Mechanika kompozitních materiálů*. 2., přeprac. vyd. Plzeň : Západočeská univerzita, 2004.
- **Recommended:** Decolon, Christian. *Analysis of composite structures*. London : Hermes Penton Science, 2002. ISBN 1-9039-9602-3.
- **Recommended:** Berthelot, Jean-Marie. *Composite materials : mechanical behavior and structural analysis*. New York : Springer, 1999. ISBN 0-387-98426-7.
- **Recommended:** Altenbach, H.; Altenbach, J.; Kissing, W. *Mechanics of composite structural elements*. Berlín : Springer, 2004. ISBN 3-540-40865-7.

Time requirements

All forms of study

Activities	Time requirements for activity [h]
Undergraduate study programme term essay (20-40)	40
Preparation for an examination (30-60)	40
Contact hours	52
Total:	**132**

assessment methods

Knowledge - knowledge achieved by taking this course are verified by the following means:

Combined exam

Skills - skills achieved by taking this course are verified by the following means:

Combined exam

Competences - competence achieved by taking this course are verified by the following means:

Skills demonstration during practicum

Seminar work

prerequisite

Knowledge - students are expected to possess the following knowledge before the course commences to finish it successfully:

mít základy diferenciálního a integrálního počtu z oblasti matematické analýzy

má znalosti z vektorového a maticového počtu z oblasti lineární algebry

mít znalosti z mechaniky poddajného tělesa

mít znalosti ze základních experimentálních metod pružnosti

Skills - students are expected to possess the following skills before the course commences to finish it successfully:

vypočítat základní typy derivací a integrálů

řešit úlohy lineární pružnosti izotropního tělesa

vyhodnocovat laboratorní měření

Competences - students are expected to possess the following competences before the course commences to finish it successfully:

N/A

N/A

teaching methods

Knowledge - the following training methods are used to achieve the required knowledge:

Lecture with visual aids

Skills - the following training methods are used to achieve the required skills:

Seminar

Laboratory work

Competences - the following training methods are used to achieve the required competences:

Students' portfolio

Self-study of literature

learning outcomes

Knowledge - knowledge resulting from the course:

navrhnout analyticky nebo numericky kompozitovou součást

popsat a klasifikovat anizotropní materiály

provést kontrolu pevnosti a tuhosti jednosměrového kompozitu

stanovit napjatost a deformaci v jednosměrovém kompozitu

Skills - skills resulting from the course:

stanovit analyticky a numericky napjatost a deformaci laminátu

stanovit materiálové charakteristiky laminátu nutné pro jejich výpočet

stanovit numericky mezní stav laminátu

vyhodnotit laboratorní měření

řešit chování anizotropních materiálů

Competences - competences resulting from the course:

N/A

N/A

Course is included in study programmes:

Study Programme	Type of	Form of	Branch	Stage St. plan v.	Year	Block	Status	R.year	R.

Study Programme	Type of	Form of	Branch	Stage	St. plan v.	Year	Block	Status	R.year	R.
Computer Modelling in Mechanics	Bachelor	Full-time	Computer Modelling in Mechanics	1	2023	2023	Povinné předměty	A	2	LS
Computer Modelling in Mechanics	Bachelor	Full-time	Computer Modelling in Mechanics	1	2020	2023	Povinné předměty	A	2	LS
Computer Modelling in Technology	Bachelor	Full-time	Computations and Design	1	2023	2023	Povinné předměty	A	2	LS
Computer Modelling in Technology	Bachelor	Full-time	Computations and Design	1	2018	2023	Povinné předměty	A	2	LS
Applied Physics and Physical Engineering	Bachelor	Full-time	Aplikovaná fyzika a fyzikální inženýrství	1	2023	2023	Povinně volitelné předměty	B	2	LS
Applied Physics and Physical Engineering	Bachelor	Full-time	Aplikovaná fyzika a fyzikální inženýrství	1	2020	2023	Povinně volitelné předměty	B	2	LS
Computer Modelling in Technology	Bachelor	Full-time	Computer Modelling	1	2023	2023	Povinně volitelné předměty	B	2	LS
Computer Modelling in Technology	Bachelor	Full-time	Computer Modelling	1	2018	2023	Povinně volitelné předměty	B	2	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Combined	Design Engineering of Health and Cooperative Technology	1	2020	2023	Core elective courses	B	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Full-time	Design Engineering of Health and Cooperative Technology	1	2020	2023	Core elective courses	B	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Full-time	Design Engineering of Manufacturing Machines and Equipment	1	2020	2023	Core elective courses "B"	B	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Combined	Design Engineering of Manufacturing Machines and Equipment	1	2020	2023	Core elective courses "B"	B	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Full-time	Design Engineering of Vehicles and Handling Machinery	1	2020	2023	Core elective courses "B"	B	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Combined	Design Engineering of Vehicles and Handling Machinery	1	2020	2023	Core elective courses "B"	B	1	LS