Course description

Department/Unit /	KME / PP2			**Academic Year**	2023/2024
Title	Mechanics of Materials 2			**Type of completion**	Exam
Accredited/Credits	Yes, 5 Cred.			**Type of completion**	Combined
Number of hours	Lecture 3 [Hours/Week] Tutorial 2 [Hours/Week]				
Occ/max	Status A	Status B	Status C	**Course credit prior to**	YES
Summer semester	38 / -	0 / -	2 / -	**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	No				
Periodicity	K				
Substituted course	None				
Preclusive courses	N/A				
Prerequisite courses	N/A				
Informally recommended courses	KME/DPP or KME/PP1				
Courses depending on this Course	KME/SZMPT				

Course objectives:

The aim of the course is to acquaint students with following problems:
Fundamentals of mathematical theory of elasticity. Finite element method. Axially symmetrical problems (spinning disks, thick-walled cylindrical vessels) - stress and strain, technical applications. Slender curved and cranked beams and frames - stiffness and strength analysis. Structural stability, fundamentals. Fundamentals of stiffness and strength analysis of components from anisotropic materials. Fundamentals of linear and non-linear fracture mechanics. Material fatigue. Construction of computational models for the solution of problems using finite element method.

Requirements on student

Requirements for credit:
Elaboration and submission of semester work having relevant quality.

Requirements for exam:
Active knowledge of lectured subject matter and its application in the solution of specific problems.

Content

Lectures:
1. Three-dimensional state of stress: principal planes, principal stresses, generalized Hooke's Law.
2. Fundamentals of mathematical theory of elasticity: Derivation of differential equations of equilibrium. Geometrical relations. Physical relations. Boundary conditions.
3. Slender curved and cranked beams: statically determinate and indeterminate. Analysis of forces, stresses, dimensions finding and deflection calculation.
4. Closed planar frames: general and symmetrical frame, influence of cross-piece. Shells: basic terms, membrane conditions. State of stress of thin-walled rotational shell.
5. Spinning disks: theory of spinning disks - disk of constant and variable thickness. Stress and strain analysis.
6. Thick-walled cylindrical vessels: Stress and strain analysis. Ring to shaft press-fitting.
7. Circular plates: Derivation of the basic equation of circular plates. Calculation of plate deformation and stresses.

8. Structural stability: critical force, analysis of Euler's theory, elastic and inelastic buckling analysis.
9. Membrane analogy 1: Stress function, torque, Stokes theorem.
10. Membrane analogy 2: Slim rectangle of torsion, quadratic torsion moment, loose twist of thin-walled open and closed profiles.
11. Fundamentals of fracture mechanics: linear fracture mechanics, Griffith concept, Irvin-Orowan concept of brittle fracture. Stress intensity factor, fracture toughness.
12. Material fatigue: fatigue fracture, cyclic loading, Wöhler's diagram. High-cycle fatigue, fatigue strength (fatigue notch factor, influence of size and surface quality, possibilities of increasing fatigue strength). Fatigue strength of real component.
13. Reserve.

Exercises:
1. Conditions for credit awarding. Review of subject matter from PP1.
2. Three-dimensional state of stress.
3. Theoretical basis for laboratory measurement.
4. Laboratory measurement.
5. Planar curved and cranked beams.
6. Closed frames. Rotational thin-walled shells.
7. Spinning disks. Semester work.
8. Thick-walled cylindrical vessels.
9. Ring to shaft press-fitting, releasing revolutions.
10. Circular plates.
11. Free twisting of open profiles.
12. Free twist of closed profiles.
13. Material fatigue. Credit awarding.

Fields of study

Guarantors and lecturers

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

Literature

- **Basic:** Hájek, Emanuel; Reif, Pavel; Valenta, František. *Pružnost a pevnost I*. Praha : SNTL, 1988.
- **Basic:** Michalec, Jiří. *Pružnost a pevnost II*. Vyd. 2. Praha : Vydavatelství ČVUT, 2001. ISBN 80-01-02375-3.
- **Extending:** Kolektiv. *Pružnost a pevnost II*. Praha : Vydavatelství ČVUT, 1980.
- **Recommended:** Gdoutos, E. E. *Fracture mechanics : an introduction*. Dordrecht : Kluwer, 1993. ISBN 0-7923-1932-X.
- **Recommended:** Jenkins, C. H.; Khanna, Sanjeev K. *Mechanics of materials : a modern integration of mechanics and materials in structural design*. Amsterdam : Elsevier Academic Press, 2005. ISBN 0-12-383852-5.
- **Recommended:** Hearn, E. J. *Mechanics of materials 1 : an introduction to the mechanics of elastic and plastic deformation of solids and structural materials*. 3rd ed. Oxford : Butterworth-Heinemann, 1997. ISBN 978-0-08-052399-6.
- **Recommended:** Hearn, E. J. *Mechanics of Materials 2: The Mechanics of Elastic and Plastic Deformation of Solids and Structural Materials. Third Edition. Oxford : Butterworth-Heinemann, 1997. ISBN 978-0750632669*.
- **Recommended:** Němec, Jaroslav; Dvořák, Jan; Höschl, Cyril. *Pružnost a pevnost ve strojírenství*. Praha : SNTL, 1989.
- **Recommended:** Kuba, František. *Teorie pružnosti a vybrané aplikace*. 2. vyd. Praha : SNTL, 1982.
- **Recommended:** Plánička, František. *Základy lomové mechaniky při statickém zatížení*. 1. vyd. Plzeň : ZČU, 1991.

Time requirements

All forms of study

Activities	Time requirements for activity [h]
Preparation for an examination (30-60)	50

Graduate study programme term essay (40-50)	30
Contact hours	65
Total:	**145**

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:

Seminar work

prerequisite

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

mít znalosti z oblasti diferenciálního a integrálního počtu

mít znalosti z oblasti matematické analýzy

mít znalosti z oblasti lineární algebry

mít znalosti z oblasti lineární pružnosti

mít znalosti o řešení napjatosti a deformace jednoduchých součástí namáhaných tahem , ohybem, krutem a jejich kombinacemi

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

umět vypočítat základní typy integrálů

umět řešit diferenciální rovnice 1. řádu metodou separace proměnných

umět řešit soustavu lineárních algebraických rovnic

umět řešit úlohy lineární pružnosti

umět řešit úlohy napjatosti a deformace jednoduchých součástí namáhaných tahem , ohybem, krutem a jejich kombinacemi

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

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

Practicum

Laboratory work

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

Individual study

Textual studies

learning outcomes

Knowledge - knowledge resulting from the course:

popsat a klasifikovat chování pružného tělesa

sestavit matice tuhosti vybraných prvků pro řešení úloh pomocí metody

sestavit na základě okrajových podmínek rovnice rovnováhy rotujících kotoučů, silnostěnných válcových nádob

sestavit rovnice pro řešení úloh stability

Skills - skills resulting from the course:

řešit analyticky napětí a deformaci křivého nebo lomeného prutu a uzavřeného rámu

řešit analyticky stav napjatosti a deformace silnostěnných válcových nádob a rotujících kotoučů

řešit analyticky úlohy stability prutů

řešit numericky s využitím software rovinné úlohy pružnosti a pevnosti

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.
Computer Modelling in Mechanics	Bachelor	Full-time	Computer Modelling in Mechanics	1	2020	2023	Povinné předměty	A	2	LS
Computer Modelling in Mechanics	Bachelor	Full-time	Computer Modelling in Mechanics	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
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	Computer Modelling	1	2018	2023	Povinné předměty	A	2	LS
Computer Modelling in Technology	Bachelor	Full-time	Computer Modelling	1	2023	2023	Povinné předměty	A	2	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Combined	Design Engineering of Health and Cooperative Technology	1	2020	2023	Compulsory courses	A	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Full-time	Design Engineering of Health and Cooperative Technology	1	2020	2023	Compulsory courses	A	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Full-time	Design Engineering of Manufacturing Machines and Equipment	1	2020	2023	Compulsory courses	A	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Combined	Design Engineering of Manufacturing Machines and Equipment	1	2020	2023	Compulsory courses	A	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Full-time	Design Engineering of Vehicles and Handling Machinery	1	2020	2023	Compulsory courses	A	1	LS
Design Engineering of Machines and Technical Devices	Postgraduate Master	Combined	Design Engineering of Vehicles and Handling Machinery	1	2020	2023	Compulsory courses	A	1	LS
Design of Power Machines and Equipment	Postgraduate Master	Full-time	Design of Power Machines and Equipment	1	2020	2023	Compulsory courses	A	1	LS
Design of Power Machines and Equipment	Postgraduate Master	Full-time	Nuclear Power Equipment Design	1	2020	2023	Compulsory courses	A	1	LS
Design	Bachelor	Full-time	Design, specialization Industrial Design	1	4	2023	Povinně volitelné - specializační - FAV	B	3	LS