Course description

Department/Unit /	KME / TP			**Academic Year**	2023/2024	
Title	Theory of Plasticity			**Type of completion**	Exam	
Accredited/Credits	Yes, 5 Cred.			**Type of completion**	Written	
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	0 / -	0 / -	0 / -	**Counted into average**	YES	
Winter semester	1 / -	2 / -	0 / -	**Min. (B+C) students**	10	
Timetable	Yes			**Repeated registration**	NO	
Language of instruction	Czech, English			**Semester taught**	Winter 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	N/A					
Courses depending on this Course	KME/PME					

Course objectives:

The main aim of this course is to introduce students into the basic principles of plasticity theory to be able to solve simple one-dimensional and two-dimensional problems.

Requirements on student

Credit requirements:
Elaboration of terminal paper.
Credit obtained in previous years of study is not accepted.

Examination requirements:
Active knowledge of theory and the ability to apply it to particular problems.

Content

1. Deformation of bodies. Mathematical model of boundary value problem in plastic state. Stress analysis: stress tensor, stress deviator tensor and stress spherical tensor, principal stresses, invariants of stress tensor.
2. Invariants of stress deviator tensor, equivalent stress. Density of deformation energy. Strain analysis: relative displacement tensor, pure deformation tensor and rotation tensor, strain deviator tensor and strain spherical tensor, invariants of strain deviator tensor. Equivalent deformation in elastic and plastic state. Volumetric change.
3. Natural strain. Deformation rate. Approximations of stress-strain curves. Static isometric plastic deformation, Bauschinger effect.
4. - 5. Initial yield criteria. Tresca and Mises yield criteria. Comparison of both criteria.
6. - 7. Axisymmetric problems: Rotating discs and thick-walled vessels, elasto-plastic and plastic state.
8. Residual stresses. Drucker's rule of stability. Initial and sequential yield surfaces. Loading function and surface.
9. Loading criteria. Drucker's postulate of stability for triaxial state of stress. Associative law of plastic flow, compatibility condition. Initial yield surface.
10. Yield surface in deviatoric plane. Sequential yield surfaces. Theory of plasticity - theory of small elasto-plastic strains.
11. Theory of plasticity - theory of plastic flow. The comparison of plasticity theories.
12. Elasto-plastic and plastic potential. Elasto-plastic torsion of cylindrical bars.

13. Membrane analogy of torsion.

Fields of study

Guarantors and lecturers

- **Guarantors:** Ing. Vítězslav Adámek, Ph.D. (100%)
- **Lecturer:** Ing. Vítězslav Adámek, Ph.D. (100%)
- **Tutorial lecturer:** Ing. Vítězslav Adámek, Ph.D. (100%)

Literature

- **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:** Chen, Wai-Fah; Han, D. J. *Plasticity for structural engineers*. Ft. Lauderdale : J. Ross, 2007. ISBN 978-1-932159-75-2.
- **Recommended:** Servít, Radim. *Teorie pružnosti a plasticity II*. Vyd. 1. Praha : SNTL, 1984.
- **Recommended:** Chakrabarty, Jagabanduhu. *Theory of Plasticity. Third Edition.*.
- **Recommended:** Plánička, František; Kuliš, Zdeněk. *Základy teorie plasticity*. Praha : ČVUT, 2004. ISBN 80-01-02876-3.

Time requirements

All forms of study

Activities	Time requirements for activity [h]
Contact hours	52
Preparation for an examination (30-60)	40
Graduate study programme term essay (40-50)	50
Total:	**142**

assessment methods

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

Seminar work

Oral exam

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

Seminar work

Oral exam

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

Seminar work

Oral exam

prerequisite

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

definovat základní pojmy z oblasti lineární teorie pružnosti

disponovat základními znalostmi v oblasti integrálního a diferenciálního počtu

orientovat se v základních metodách řešení obyčejných diferenciálních rovnic

mít základní znalosti z teorie maticového a tenzorového počtu

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

derivovat a integrovat základní matematické funkce

provádět základní operace s maticemi a vektory (sčítání, násobení, inverze, apod.)

sestavit model lineární úlohy pružnosti

řešit obyčejné lineární diferenciální rovnice metodou separací proměnných

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

N/A

teaching methods

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

Practicum

Self-study of literature

Lecture supplemented with a discussion

One-to-One tutorial

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

Lecture supplemented with a discussion

Practicum

One-to-One tutorial

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

Lecture with visual aids

Practicum

Task-based study method

learning outcomes

Knowledge - knowledge resulting from the course:

definovat zobecněné napětí a deformaci

popsat matematický model okrajové úlohy v plastickém stavu

vysvětlit význam jednotlivých invariantů tenzoru napětí a deformace a jejich deviátorů

vysvětlit pojmy počáteční a následná podmínka plasticity a popsat základní modely zpevnění

popsat základní typy aproximací pracovního diagramu

Skills - skills resulting from the course:

formulovat Trescovu či Misesovu podmínku plasticity pro zadanou 1D a 2D úlohu

provést analýzu napjatosti v elasto-plastickém stavu u vybraných rotačně symetrických úloh

sestavit rovnice popisující jednoduché úlohy tváření

řešit základní typy namáhání těles (tah, krut, ohyb) při uvažování plastických deformací

stanovit zbytková napětí při odlehčení z plně plastického a elasto-plastického stavu pro základní typy namáhání (tah, krut, ohyb)

Competences - competences resulting from the course:

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.
Applied Mechanics	Postgraduate Master	Full-time	Výpočty a design konstrukcí	1	2018 akr	2023	Povinné předměty - specializace	A	2	ZS

Study Programme	Type of	Form of	Branch	Stage	St. plan v.	Year	Block	Status	R.year	R.
Applied Mechanics	Postgraduate Master	Full-time	Dynamika konstrukcí a mechatronika	1	2018 akr	2023	Povinně volitelné předměty - specializace (typ B)	B	2	ZS