THE DOCTORAL SCHOOL OF IPPT PAN

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

Name of the course	Polish	**Mechanika Ośrodków Ciągłych**			
	English	**Mechanics of Continuum**			
Type of the course	**Introductory Lecture**				
Course coordinator	**prof. dr hab. inż Katarzyna Kowalczyk-Gajewska**		Course teacher	**prof. dr hab. inż Katarzyna Kowalczyk-Gajewska**	
Implementing unit	**ZMM**	Scientific discipline / disciplines	**Mechanical Engineering / Materials Science**		
Level of education	**Doctoral studies**	Semester	**Summer**		
Language of the course	**English or Polish**				
Type of assessment	**exam**	Number of hours in a semester	**45**	ECTS credits	**4**

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	**2**	**1**	**0**	**0**	**0**
	in a semester	**30**	**15**	**0**	**0**	**0**

1. Prerequisites

Knowledge of fundamentals of tensor calculus necessary for the description of problems within continuum mechanics (including basic notion of linear algebra, definition of a tensor product and other tensor operations, invariant decompositions of tensors of a second and fourth order, symmetry groups of tensors and tensor functions and elements of tensor analysis), basic knowledge in Newtonian classical mechanics .

2. Course objectives

The goal of the course is to present and deepen basic concepts of continuum mechanics, namely description of kinematics of deformable material body within the large strain framework, the stress measures definitions, conservation laws and a short overview of classical constitutive models.

3. Course content (separate for each type of classes)

Lecture

1. Description of motion and deformation of a body within the large strain regime (e.g.:deformation and strain measures, interpretation of their components, velocity field and a material derivative, the change of the infinitesimal volume and surface elements).
2. Stress state (e.g: Cauchy stress principle, eigen-value problem for the stress tensor, stress measures at the reference configuration).
3. Conservation laws in Continuum Mechanics (e.g.: global and local formulations in the current and reference configurations, thermodynamics principles).
4. Constitutive equation (e.g.: objectivity principle, anisotropic linear elasticity and thermo- elasticity at small strains, hyper-elasticity and hypo-elasticity at finite strains, fundamentals of plasticity and visco-plasticity theory).

Auditory Classes

Solving specific problems related to the theory presented in the course of the lecture.

5. Learning outcomes			
Number of the learning outcome	Learning outcomes description	Reference to the learning outcomes according to the 8th level of PRK	Learning outcomes verification methods*
Knowledge			
1	The graduate acquires basic knowledge of the rigorous description of large deformation of solid body and the stress field	P8S_WG	Homeworks/examination
2	The graduate acquires basic knowledge of the mathematical description of conservation rules valid for any solid and the possible constitutive relations	P8S_WG	Homeworks/examination
3	The graduate knows how to transfer the acquired knowledge to his/her research field and proper dissemination of results	P8S_WK	Assessment of activity during classes
Skills			
1	The graduate is able to solve problems of solid body thermomechanical response under loading.	P8S_UW	Homeworks/examination
2	The graduate is able to select the proper description of material behavior for the given range of deformation and themo-mechanical conditions.	P8S_UW	Homeworks/examination
3	The graduate is able to critically analyze the correctness and scope of applicability of the performed thermo-mechanical analysis	P8S_UW	Homeworks/examination/ Assessment of activity during classes
4	The graduate is able to apply the continuum mechanics in his research field and use in the industrial applications	P8S_UW	Assessment of activity during classes
Communication			
1	The graduate is able to communicate his/her results in a clear and rigorous way in the international scientific community	P8S_UK	Examination/Assessment of activity during classes
Social competences			
1	The graduate is ready to think and act in a creative and entrepreneurial way.	P8S_KO	Assessment of activity during classes
2	The graduate is ready to critically evaluate the achievements of the represented scientific discipline, including the existing literature and his or her own contribution to the development of this discipline	P8S_KK	Assessment of activity during classes

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

6. Assessment criteria
Activity during classes, written assignments (homeworks), results of oral examination

7. Literature

Primary references:

[1] G. A. Holzapfel, Nonlinear Solid Mechanics. Wiley, 2001.

[2] G. Mase. Theory and Problems of Continuum Mechanics. Schaum's outlines. McGraw-Hill, 1 edition, 1969, multiple re-editions.

Secondary references:

[1] JJ. Ostrowska-Maciejewska. Mechanika Ciał Odkształcalnych. PWN, Warszawa 1993, IPPT PAN 2021 [In Polish]

[2] M. Silhavy, The Mechanics and Thermodynamics of Continuous Media. Springer, 2010

[3] J.C. Simo and T.J.R. Hughes, Computational Inelasticity. Springer, 1998

8. PhD student's workload necessary to achieve the learning outcomes**

No.	Description	Number of hours
1	Hours of scheduled instruction given by the lecturer in the classroom	**45**
2	Hours of consultations with the lecturer, exams, tests, etc.	**15**
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	**25**
4	Amount of time devoted to the preparation for exams, test, assessments	**15**
	Total number of hours	**100**
	ECTS credits	**4**

** 1 ECTS = 25–30 hours of the PhD students work (2 ECTS ≈ 60 hours; 4 ECTS ≈ 110 hours, etc.)