THE DOCTORAL SCHOOL OF IPPT PAN

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

Name of the course	Polish	**Fizyczne podstawy metod doświadczalnych stosowanych w mechanice**
	English	**The physical basis of experimental methods used in mechanics**

Type of the course	**Lectures**		
Course coordinator	**Prof. Wiera Oliferuk, Ph.D., D.Sc.,**	Course teacher	**Prof. Wiera Oliferuk, Ph.D., D.Sc.,**
Implementing unit	**Laboratory of Thermoplasticity Department of Materials**	Scientific discipline / disciplines	**Mechanical engineering, Materials science**
Level of education	**doctoral studies**	Semester	**summer or winter**
Language of the course	**English or Polish**		
Type of assessment	**examination**	Number of hours in a semester	**30**
		ECTS credits	**3**

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

1. Prerequisites

Knowledge of the laws of physics and understanding their mathematical notation. These skills fall within the requirements of higher technical studies.

2. Course objectives

- to demonstrate that the basis for determining any physical quantity characterizing the object being studied is a specific phenomenon described by the laws of physics,
- to encourage PhD students involved in process modeling to relate the assumptions introduced to the results of experiments,
- to analyze examples of non-destructive experimental methods and show the importance of these methods in modern mechanics.

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

Lecture

1. Introduction
   - the structure of modern scientific research,
   - the concept of experimental method in natural sciences and technology,
   - experimental methods in the pre-scientific world,
   - Galileo Galilei as a precursor of modern experimental methods in mechanics,
   - metrology and its beginnings, International System of Units.

2. Material properties determining its response to mechanical loading:
   - the definitions of stress and strain and a choice of measure for these quantities,
   - investigation of a material subjected to uniaxial loading,

a) yield point and methods of its determination,
b) the dependence of yield point on strain rate,
c) Young's modulus and methods of its determination.
d) strain fields during material deformation – DIC method (Digital Image Correlation)

3. Energy balance in a material deformation process:

- physical quantities describing a thermodynamic state of a deformed material: internal energy, entropy, and free energy, - energy storage process during plastic deformation,
- stored energy and experimental methods of its determination,
- the concept of energy storage rate as a measure of the plastic work partition into the. stored energy and heat at each instant of the deformation process.

4. Instability of plastic deformation:

- Considère's criterion and its limitations,
- loss of energy storage rate in the area of plastic deformation localization as an indicator of plastic deformation instability,
- finding the point of plastic deformation instability based on the determination of the energy storage rate during a material deformation process.

5. Non-destructive experimental test methods:

- physical phenomena used in nondestructive test methods: basics of ultrasonic methods, eddy currents and non-contact measurement of temperature fields,

Laboratory
does not apply

4. Learning outcomes			
Number of the learning outcome	4. Learning outcomes description	Reference to the learning outcomes according to the 8th level of PRK	Learning outcomes verification methods*
Knowledge			
1	The graduate knows and understands that determining any physical quantity characterizing the object being studied is based on the appropriate physical law.	P8S_WG	examination
2	The graduate knows how to describe material deformation, knows and understands the essence of the parameters needed for this description.	P8S_UW	examination
3	The graduate knows how to use the acquired knowledge in possible numerical modelling of the studied processes and is able to disseminate this knowledge.	P8S_WK	assessment of activity during classes

Skills			
1	The graduate is able to use the DIC (Digital Image Correlation) method to determine strain fields in the deformation process of the tested material.	P8S_UW	examination
2	The graduate is able to design a stand for testing the process of energy conversion during the deformation of the tested material.	P8S_UW	examination
3	The graduate is able to design a stand for testing the process of energy conversion during the deformation of the tested material.	P8S_UW	assessment of activity during classes and examination
4	The graduate is able to transfer the acquired knowledge to the industrial sphere and disseminate the results of his research.	P8S_UW	assessment of activity during classes and
Social competences			
1	The graduate is able to analyze a research task in a creative way, i.e. tries to improve or simplify the research process.	P8S_KO	assessment of activity during classes
2	The graduate is able to critically evaluate the achievements of the represented scientific discipline, including their 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.

5. Assessment criteria
assessment of activity during classes, results of the examination.

6. Literature
Primary references:
[1] M. B. Bewer, D. L. Hold, A. L. Titghener, **THE STORED ENERGY OF COLD WORK,** Pergamon Press, Oxford, New York, Toronto, Sydney, Braunshweig, 1973.
[2] H. B. Callen, **THERMODYNAMICS,** John Willey and Sons, New York, London, 1960
Secondary references:
[1] A. Oleś, **EXPERIMENTAL METHODS OF SOLID STATE PHYSICS,** (in Polish) Scientific and Technical Publishing House, Warsaw, 1998,
[2] W. Oliferuk**, INFRARED THERMOGRAPHY IN NON-DESTRUCTIVE TESTING OF MATERIALS AND DEVICES,** (in Polish) Gamma Office, Warsaw, 2007**.**

7. 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	**30**
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	**35**
	Total number of hours	**105**
	ECTS credits	**3**

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