Cracow University of Technology

Course syllabus

binding for the doctoral students of the CUT Doctoral School commencing their studies in the academic year 2022/2023

Information on the course

Name of the course in Polish	Mechanika pól sprzężonych
Name of the course in English	Mechanics of coupled fields
Number of the ECTS points	1
Language of instruction	Polish
Category of the course	Choosable
Field of education	Engineering and technology
Discipline of education	Mechanical engineering
Person responsible for the course Contact	prof. Artur Ganczarski, *doctor habilitatus* artur.ganczarski@pk.edu.pl

Type of course, number of hours in the study programme curriculum

Semester	Credit type (G / NG)*	Lecture	Practical classes	Laboratory	Computer Lab	Project Class	Seminar
2, 3, 4, 5	G	15	0	0	0	0	0

*G – graded credit, NG – non-graded credit

Course objectives

Code	Objective description
Objective 1	Introduction to the basic elements of coupled field mechanics.
Objective 2	Acquiring skills in the field of analytical and computational methods of solving problems of coupled field mechanics.

Learning outcomes

Code	Description of the learning outcome adjusted to the specific characteristics of the discipline	Learning outcome symbol in the CUD DS	Methods of verification
OUTCOMES RELATED TO KNOWLEDGE			
EUW1	The doctoral student knows and understands the theoretical foundations as well as general issues and selected specific issues of the mechanics of coupled fields.	E_W01	Involvement in class activities, assessment of the test or the project
EUW2	The doctoral student knows and understands the main development trends of coupled field mechanics.	E_W02	Involvement in class activities, assessment of the test or the project
OUTCOMES RELATED TO SKILLS			

EUU1	The doctoral student is able to use knowledge from various fields of science for creative identification and innovative solving of complex problems.	E_U01	Involvement in class activities, assessment of the test or the project
OUTCOMES RELATED TO SOCIAL COMPETENCES			
EUK1	The doctoral student is ready to critically evaluate the achievements within the discipline of his doctoral dissertation.	E_K01	Involvement in class activities, assessment of the test or the project

Course outline

No.	Contents	Learning outcomes for the course	No. of hours
LECTURE			
W1	Field theory overview: solid state mechanics, heat conduction theory, diffusion, electro-magnetism theory, etc. Examples of coupled fields.	EUW1, EUW2, EUU1, EUK1	2
W2	Basics of thermodynamics - the law of conservation of energy, the second law of thermodynamics - the law of heat conduction - constitutive equations of thermo-elasticity - identification of material constants of the anisotropic medium - analytical and numerical methods of thermo-elasticity - selected examples of thermo-elasticity issues (brake disc, piston, a tool made of advanced material)	EUW1, EUW2, EUU1, EUK1	2
W3	Basics of coupled thermo-damage problems - basic principles of damage mechanics - damage evolution equation - the impact of the damage on the heat flow - theories of compression failure with creep and plasticity - methods of thermo-damage analysis - selected examples of thermo-damage issues	EUW1, EUW2, EUU1, EUK1	2
W4	Basics of coupled electromagnetic fields - main principles of electrodynamics - Maxwell's equations - constitutive equations of elasticity coupled with the electromagnetic effect - equations of piezo- and ferromagnetic materials - methods of analysis of coupled mechanical-electromagnetic fields - selected examples of compressed mechanical-electromagnetic problems (smart materials, materials undergoing phase changes)	EUW1, EUW2, EUU1, EUK1	4
W5	Fundamentals of mechanics of porous media saturated with liquid - main principles of multiphase materials theory - influence of liquid pressure in pores on stress in the solid phase - consolidation equation - methods of analysis of porous materials - selected examples of issues for porous materials (biomaterials)	EUW1, EUW2, EUU1, EUK1	2
W6	Overview of basic equations in mathematical physics - basic types of partial equations - analytical and numerical solving methods	EUW1, EUW2, EUU1, EUK1	2

W7	Overview of the possibilities of commercial FEM packages in terms of solving the problems of coupled fields	EUW1, EUW2, EUU1, EUK1	1

The ECTS points statement

WORKING HOURS SETTLEMENT	
Type of activity	Average number of hours (45 min.) dedicated to the completion of an activity type
SCHEDULED CONTACT HOURS WITH AN ACADEMIC TEACHER	
Hours allotted in the syllabus	15
Consultations	1
Examination / course credit assignment	2
HOURS WITHOUT THE PARTICIPATION OF AN ACADEMIC TEACHER	
Independent study of the course contents	8
Preparation of a paper, a report, a project, a presentation, a discussion	4
ECTS POINTS STATEMENT	
Total number of hours	30
The ECTS points number	1

Preliminary requirements

No.	Requirements
1	Basic knowledge of the theory of elasticity and the theory of plasticity.
2	Basic knowledge of matrix-tensor calculus.

Course credit assignment conditions / method of the final grade calculation

No.	Description
COURSE CREDIT ASSIGNMENT CONDITIONS	
1	75% attendance in class.
2	Passing the test or completing the project.
METHOD OF THE FINAL GRADE CALCULATION	
Grade for the test or for the project.	

Additional information

None specified.

The course reading list

1	Fung Y.C., *Podstawy mechaniki ciała stałego*, 1969, PWN.
2	Lekhnitskii S.G., *Theory of elasticity of an anisotropic body*, Moskow, 1977, Mir Publ.
3	Nowacki W., *Teoria niesymetrycznej sprężystości*, Warszawa, 1981, IPPT PAN.
4	Ostrowska-Maciejewska J., *Podstawy mechaniki ośrodków ciągłych*, Warszawa, 1982, PWN.
5	Rymarz Cz., *Mechanika ośrodków ciągłych*, Warszawa, 1993, PWN.
6	Ottosen N.S., Ristinmaa M., *The mechanics of constitutive modeling*, 2005, Elsevier.
7	Ganczarski A., Skrzypek J., *Plastyczność materiałów inżynierskich, podstawy, modele, metody i zastosowania komputerowe*, 2009, Drukarnia PK.

8	Ganczarski A., Skrzypek J., *Mechanika nowoczesnych materiałów*, 2013, Drukarnia PK.
9	Skrzypek J., Ganczarski A., *Mechanics of anisotropic materials*, 2015, Springer Verlag.