COURSE DESCRIPTION CARD - SYLLABUS

Course name
MODELLING AND COMPUTING IN MECHANICAL ENGINEERING

Course

Proposed by Discipline
Mechanical Engineering

Type of studies
Doctoral School

Form of study
full-time

Year/Semester
II/3, III/5

Course offered in
English

Requirements
elective

Number of hours

Lecture	Tutorials	Projects/seminars
4		

Number of credit points

1

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:

Prerequisites

Knowledge: knowledge of mathematics, mechanics, fluid mechanics, strength of materials, heat transfer and differential equations, numerical methods.

Skills: logical thinking, the use of information obtained from the library and the Internet.

Social competencies: understanding the need for learning and acquiring new knowledge.

Course objective

The doctoral student should extend obtained knowledge of theoretical and computational fundamentals for solution of partial differential equation problems modeling and governing technical, engineering and nature problems, using finite element method/analysis. The doctoral student should obtain knowledge of theoretical and computational fundamentals for solution of basic problems using topology optimization and evolutionary computation in technology. The doctoral student should obtain knowledge about materials with “negative” properties.

Course-related learning outcomes

Knowledge

A PhD student who graduated from doctoral school knows and understands:
1) global achievements, covering theoretical basis as well as general and selected specific issues, that are specific to scientific disciplines studied at the doctoral school, the extent that enables revision of existing paradigms, [P8S_WG/SzD_W01]
2) key developmental trends of science disciplines in which education takes place at the doctoral school. [P8S_WG/SzD_W02]

Skills

A PhD student who graduated from doctoral school can:
1) use the knowledge from different branches of science to creatively identify, formulate and to innovatively solve complex problems or to execute research tasks in particular:
- define the aim and subject of scientific research, form a research hypothesis,
- develop research methods, techniques and tools and use them creatively,
draw conclusions on the basis of research results, [P8S_UW/SzD_U01]
2) critically analyze and asses scientific research results, work of experts and other creative activities together with their contribution into knowledge development. [P8S_UW/SzD_U02]

Social competences

A PhD student who graduated from doctoral school is ready to:
1) critically assess the achievements within a given scientific discipline, [P8S_KK/SzD_K01]
2) critically evaluate their own contribution to the development of a given scientific discipline. [P8S_KK/SzD_K02]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

PQF code	Methods for verification of learning outcomes	Assessment criteria
W01, W02	Assessment based on realisation of the project related to the content of the selected issue performed on lecture or in topic of lecture. Evaluated is the form (e.g. graphical presentation) and the scientific quality of the prepared manuscript (description of issue, methods, tools, results, analysis and conclusions)	Clarity of explanation, Accuracy, Impact, Legibility, Originality
U01, U02	as above	as above
K01, K02	as above	as above

Programme content

1. Sciences (Sciences = Theory + Experiment + Computing).
2. Modelling and computation of problems (general partial differential equation – coefficient form of equation. Modeling, building and solving a problems: heat transfer; structural mechanics; thermal-structural interaction (thermal stresses); fluid dynamics. Basis of finite element method).
3. Modelling of materials and structures (materials with unusual mechanical properties. Materials with negative properties).
4. Topology optimization and evolutionary computation in mechanical engineering (examples of TO & EC in mechanical engineering issues).

Teaching methods

Lecture: multimedia presentation including illustrations and examples.

Bibliography

Basic

1. Zienkiewicz O.C.,Taylor R.L. (2000): The Finite Element Method, Volume 1-3, Butterworth-Heinemann, Oxford, 2000.

2. Zimmerman William B. J. (2006): Multiphysics Modeling With Finite Element Methods, Series on Stability: Vibration and Control of Systems, Series A - Vol. 18, 2006.

3. Bendsøe M P and Sigmund O. (2003): Topology optimization. Theory, Methods and Applications Springer Verlag, Berlin.

4. Lim T-C. (2015): Auxetic Materials and Structures, Springer, Singapore.

5. Lim T-C. (2020): Mechanics of Metamaterials with Negative Parameters, Springer Nature Singapore Pte Ltd.

Additional

1. Bendsøe, M. P. (1989). "Optimal shape design as a material distribution problem". Structural Optimization. 1 (4): 193–202. doi:10.1007/BF01650949.

2. Journal IACM Expressions - https://iacm.info/category/iacm-expressions/ or http://www.ptmkm.pl/pl/node/8

Breakdown of average student's workload

	Hours	ECTS
Total workload	16	1.0
Classes requiring direct contact with the teacher	8	0.5
Student's own work (literature studies, preparation for tutorials, project preparation) [1]	8	0.5

[1] delete or add other activities as appropriate