COURSE DESCRIPTION CARD - SYLLABUS

Course name
EFFICIENT METHODS FOR SENSITIVITY COMPUTATION IN COMPLEX ENGINEERING SYSTEMS – FUNDAMENTALS AND APPLICATIONS [S5ILIT>EMOW]

Course

Proposed by Discipline
–

Year/Semester
3/5

Level of study
Doctoral School

Course offered in
English

Form of study
full-time

Requirements
elective

Number of hours

Lecture
4

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

1,00

Coordinators

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Lecturers

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Prerequisites

Knowledge: - basic knowledge of higher mathematics (mathematical analysis, linear algebra, differential equations), - basic knowledge of numerical methods used in engineering. Skills: - ability to apply computational methods to solve simple engineering problems. Social competencies: - willingness to independently deepen knowledge and develop skills.

Course objective

The aim of the course is to introduce students to the concept of sensitivity as well as the theoretical and practical aspects of sensitivity analysis in complex engineering systems. Students will gain knowledge of efficient methods for sensitivity analysis, their applications in engineering modeling and research, and the ability to use numerical tools to solve selected problems.

Course-related learning outcomes

Knowledge
A PhD student who graduated from doctoral school knows and understands:
- global achievements covering the theoretical foundations of sensitivity analysis in engineering, including current research trends [P8S_WG/SzD_W01],
- key developmental trends in sensitivity analysis applied in engineering [P8S_WG/SzD_W02],

- scientific research methodology in the field of modeling and sensitivity computations in complex engineering systems [P8S_WG/SzD_W03].

Skills
A PhD student who graduated from doctoral school can:
- define the aim and subject of research, select and apply efficient methods for sensitivity analysis (P8S_UW/SzD_U01),
- critically analyze results of sensitivity studies and assess their importance for the development of engineering knowledge (P8S_UW/SzD_U02),
- plan and implement research projects related to the application of sensitivity analysis methods, also in the international research community (P8S_UO/SzD_U09).

Social competencies
A PhD student who graduated from doctoral school is ready to:
- critically assess achievements in the field of sensitivity analysis methods [P8S_KK/SzD_K01],
- acknowledge the importance of knowledge and sensitivity analysis methods in solving engineering problems [P8S_KK/SzD_K03),
- conduct independent research activity and respect the principles of intellectual property protection in relation to developed methods and results [P8S_KR/SzD_K07].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Methods for verification of learning outcomes:
Preparation of a written paper including a discussion of a case study on the application of sensitivity analysis to a selected engineering problem, including one related to the doctoral dissertation in progress or described in the literature.
Assessment criteria:
Correctness and precision in formulating the research problem and objective, appropriateness of the selected tools, and correctness of the formulated conclusions.
The final grade will be based on the percentage of task completion:
<50-60) - 3.0
<60-70) - 3.5
<70-80) - 4.0
<80-90) - 4.5
<90-100) - 5.0

Programme content

The course covers an introduction to the concept of sensitivity and methods of its analysis. Applications of sensitivity analysis in complex engineering systems are discussed, including static, dynamic, and eigenvalue problems, as well as examples from the literature. The course also addresses the use of sensitivity analysis in optimization, parameter identification, and uncertainty analysis.

Course topics

1) Introduction: concept of sensitivity, basic definitions and classifications of sensitivity analysis methods, applications in engineering problems.

2) Overview of methods: direct method, adjoint method, finite difference method.

3) Applications in engineering systems: sensitivity analysis of static and dynamic responses as well as eigenvalue problems with respect to variations of design parameters.

4) Case studies: sensitivity analysis in structural mechanics, vibration problems, and selected engineering applications.

5) Research perspectives: examples of applying sensitivity analysis in selected engineering problems (optimization, parameter identification, consideration of design parameter uncertainties).

Teaching methods

- lecture supported by presentation,
- illustrating concepts with engineering application examples,
- discussion with students.

Bibliography

Basic:
1. Kyung K. Choi , Nam Ho Kim, Structural Sensitivity Analysis and Optimization I - Linear Systems, Springer-Verlag New York 2005
2. Kyung K. Choi , Nam Ho Kim, Structural Sensitivity Analysis and Optimization II - Nonlinear Systems and Applications, Springer-Verlag New York 2005
3. H. Ciurej, Analiza wrażliwości konstrukcji prętowych w liniowej statyce. Wydawnictwo Politechniki Krakowskiej, Kraków, 2015.

Additional:
1. M. Łasecka-Plura, A comparative study of the sensitivity analysis for systems with viscoelastic elements, Archive of Mechanical Engineering, 2023, vol. 70, no. 1, s. 5-25
2. M. Kleiber, Parameter Sensitivity in Nonlinear Mechanics. Wiley, New York, 1997.
3. Cz. Szymczak, Podstawy teorii projektowania. Państwowe Wydawnictwo Naukowe, Warszawa, 1998.

Breakdown of average student's workload

	Hours	ECTS
Total workload	25	1,00
Classes requiring direct contact with the teacher	4	0,00
Doctoral student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)	21	1,00