COURSE DESCRIPTION CARD - SYLLABUS

Course name
MECHANICAL SYSTEMS SIMULATION WITH MATLAB SIMSCAPE

Course

Proposed by Discipline
Mechanical Engineering
Type of studies
Doctoral School
Form of study
full-time

Year/Semester
II/4
Course offered in
English
Requirements
elective

Number of hours

Lecture	Tutorials	Projects/seminars
8		

Number of credit points

2

Lecturers

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

Prerequisites

Knowledge:

Students should have a fundamental understanding of mechanical engineering principles, including mechanics, dynamics, and systems theory. A basic familiarity with the MATLAB programming environment and syntax is recommended, as the course relies on MATLAB and Simulink for modelling and simulation tasks. Additionally, a good foundation in physics and mathematics, particularly in calculus, differential

equations, and linear algebra, is desirable to grasp the theoretical concepts and mathematical models discussed in the course.

Skills:

Prior computational skills, especially basic programming skills in MATLAB, are important for students to effectively engage with the course material. Students should be comfortable using computer-aided engineering tools and have the ability to interpret and analyse data. Problem-solving skills in engineering contexts will enable students to tackle the modelling and simulation challenges presented in the course.

Social competencies:

Students understand the need for continuous learning, are aware of the role of science in the development of technology and civilization, have the ability to work in a team. They understand ethical responsibilities and professionalism in engineering practice is necessary.

Course objective

The objective of this course is to equip doctoral students with the skills and knowledge to effectively use MATLAB Simscape for modeling, simulating, and analyzing mechanical systems. Students will learn to create accurate physical models, perform dynamic simulations, and implement control systems, thereby enhancing their ability to solve complex engineering problems and optimize mechanical designs.

Course-related learning outcomes

Knowledge

A PhD student who graduated from doctoral school knows and understands:

1) a comprehensive understanding of MATLAB and Simulink as powerful tools for computational modeling and simulation in mechanical engineering .They will learn the fundamentals of Simscape as an extension for physical modeling, enabling them to represent and simulate mechanical systems accurately [P8S_WG/SzD_W03].
2) detailed knowledge of the various mechanical components available in Simscape, including translational and rotational elements, gears, linkages, and dampers. They will understand the principles of creating custom components and integrating them into larger systems [P8S_WG/SzD_W03].

Skills

A PhD student who graduated from doctoral school can:

1) build and simulate both simple and complex mechanical systems using MATLAB Simulink and Simscape [P8S_UK/SzD_U10], [P8S_UW/SzD_U01],
2) enhance their analytical skills by performing simulations, extracting data, and analyzing system behaviors [P8S_UK/SzD_U10], [P8S_UW/SzD_U01]
3) identify and solve problems related to mechanical system modeling and simulation, utilizing various tools and techniques provided by Simscape [P8S_UK/SzD_U11], [P8S_UW/SzD_U01]
4) optimize and parameterize mechanical systems for improved performance [P8S_UK/SzD_U11]

Social competencies

A PhD student who graduated from doctoral school is ready to:

1) critically asses achievements within a given scientific discipline , [P8S_KK/SzD_K01]
2) fulfilling the social obligations of researches and creators . [P8S_KO/SzD_K04]
3) understand of the ethical and professional responsibilities related to mechanical engineering and the use of simulation tools. [P8S_KR/SzD_K07]

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
W03	written final test covering the verification of theoretical knowledge, 10 questions from the material presented during the lectures	number of points 10, pass rate 50%
U01, U10, U11	preparation of a custom model in MATLAB Simscape for a selected topic and the submission of a written description of the model and process of its preparation.	The choice of material, its completeness and the quality of preparation
K01, K04, K07	Additional questions in written final test of social skills in the subject, two open questions	number of points 4, pass rate 50%

Programme content

This course provides a comprehensive introduction to the simulation and modeling of mechanical systems using MATLAB, Simulink and Simscape. Students will learn to use MATLAB's Simulink environment to create physical models, simulate dynamic systems, and analyze the performance of various mechanical components.

Course topics

Lecture 1: Introduction to MATLAB and Simulink
Lecture 2: Getting Started with Simscape
Lecture 3: Modeling Mechanical Components
Lecture 4: Combining Simscape Models and Simulink Models
Lecture 5: System Dynamics and Analysis
Lecture 6: Introduction to Control Systems with Simscape
Lecture 7: Introduction to Simscape Multibody for modeling complex rigid body systems.
Lecture 8: Introduction to parameterization and optimization of mechanical systems using Simscape

Teaching methods

Lecture: multimedia presentation including modelling examples in Matlab, Simulink and Simscape

Bibliography

Basic

1. Shuvra Das: Modeling and Simulation of Mechatronic Systems using Simscape, Synthesis Lectures on Mechanical Engineering, Springer Cham, 2020,

Additional

1. Ramin S. Esfandiari: Modeling and Analysis of Dynamic Systems, 3e, California State University; Bei Lu, Shanghai Jiao Tong University, CRC Press, Inc., 2018,
2. Kevin Russell, John Q. Shen, Raj Sodhi: Kinematics and Dynamics of Mechanical Systems: Implementation in MATLAB® and Simscape Multibody™: Implementation in MATLAB(R) and Simscape Multibody(TM),2022, CRC Press,

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,0
Classes requiring direct contact with the teacher	8	0
Doctoral student's own work (literature studies, preparation for tutorials, project preparation) [1]	42	2,0

[1] delete or add other activities as appropriate