Module name:	Module code
modelling and simulation	MSI

Responsible for the module	Faculty
Prof. Dr. Stefan Körkel	Computer Science and Mathematics

Semester of study	Year of study	Module type	Credit points [ECTS-Credits]
6. / 7.	3.	compulsory module	5

Compulsory prerequisites
Successful completion of all examinations of the 1st study section At least 100 credits from the 1st and 2nd study sections
Recommended prior knowledge
• Mathematics 1 • Mathematics 2 • Linear methods of AI • Non-linear methods of AI

Content
see following page

Assigned submodules:

Nr.	Designation of the sub-modules	Scope of teaching [SWS or UE]	Credit points [ECTS-Credits]
1.	modelling and simulation	4 SWS	5

Sub-module	TM- abbreviation
Modelling and Simulation	**MSI**

Responsible	Faculty
Prof. Dr. Stefan Körkel	Computer Science and Mathematics
Lecturer(s)	Course frequency
Prof. Dr. Stefan Körkel	
Teaching form	
Seminars and project work	

Semester according to study plan	Scope of teaching [SWS or UE]	Teaching language	Credit points [ECTS-Credits]

6. / 7.	4 SWS	English	5

Time required:

Study in attendance	Private study
60 h	90 h

Course and examination achievement
Portfolio examination

Contents

Part 1: Theory

- Introduction to modelling and simulation (overview, goals, terminology)
- Overview of modelling methods (e.g. empirical models, black-box models,
- models from physical laws, discrete-event models, continuous models,
- deterministic models, stochastic models, hybrid models)
- Examples from application areas (e.g. mechanics, process engineering, electrical engineering, biology, epidemiology, production, transport, financial markets), historical examples (42)
- Mathematical analysis of the models (type of equations, initial and boundary value problems, well-posedness, behaviour of solutions, differentiability, stability, chaos, etc.),
- Methods for simulation: approaches (e.g. linearisation, discretisation, parameterisation), methods (e.g. Monte Carlo, initial value problem solvers, PDG methods), software
- Errors (model errors, data errors, discretisation errors, numerical errors, etc.)
- Model validation (experiments, parameter estimation, model discrimination, experimental design)

Part 2: Project (alone or in small groups)

- Familiarisation with a process from an application
- Creation of a model
- Analysis of the properties of the model
- Selection of a suitable simulation method
- If necessary, carrying out simulation calculations

Learning objectives: Technical competence

After successful completion of the submodule, students are able to:

- describe different modelling methods (2).
- formulate models of application examples (3).
- analyse models and the behaviour of their solutions (3).
- describe different simulation methods (2).
- select suitable simulation methods for specific models (3).
- carry out simulation calculations (3).
- interpret the results (3).

Learning objectives: Personal competence

After successful completion of the submodule, students are able to:

- to work on interdisciplinary problems (ability to work in a team) (3).
- work with specialised literature (methodological competence) (3).
- work independently on a task with several sub-steps (methodological competence) (3).
- work in teams (teamwork) (2).
- present the results of their own work (presentation competence) (3).

Teaching materials offered

If applicable, script, exercises, specialist literature, software, e.g. Octave, Matlab, Python libraries

Teaching media

Blackboard and presentation, computer room

Literature

- G. Golub and J.M. Ortega. Scientific Computing. Springer, 1996.
- H. Bossel. Modellbildung und Simulation. Vieweg; 1992.
- H.J. Bungartz et al. Modellbildung und Simulation. Springer, 2013.

Further information on the course

The topics of the project work are assigned by the lecturer at the beginning of the semester.

The numbers in brackets indicate the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply.