Course title: Mathematical Modeling

Course code: BWLM181

Responsible (and substitute): Prof. Sleman Saliba | Prof. Ivica Rogina

Weekly lecture hours (SWS): 4

ECTS credits: 6

Type of course: Lecture with integrated exercise

Level of course: Master students (or Bachelor students of Business Administration in higher semesters)

Examination: Written exam (90 minutes) or Project work or oral exam (20 minutes)

Language of instruction: English

Learning outcome (competencies): Students learn to translate real-world problems from the natural, economic, and social sciences into mathematical models, and to analyze and evaluate them. They

- understand the modeling process from the real-world problem to the mathematical and numerical solution;
- are familiar with basic model types from one or more subfields of mathematical modeling (such as optimization, game theory, statistics, and operations research);
- are able to select appropriate assumptions, simplifications, and mathematical methods for given problems;
- use software tools (e.g., Python, MATLAB, R, or solvers for optimization problems) in a targeted manner;
- and critically evaluate models in terms of their validity, data dependence, and limitations.

Contents: The course content is based on a specific area of focus within mathematical modeling. Examples of such areas include:

Focus on Operations Research:

- Modeling real-world decision-making problems using linear, mixed-integer, nonlinear, or combinatorial optimization models;
- Decision-making under uncertainty, including stochastic programming;
- Heuristic and metaheuristic solution methods;
- Sensitivity analysis

Focus on Game Theory:

- Modeling of Decision-Making Processes (Single-Player Games);
- Mathematical Modeling of Various Types of Multiplayer Games, Such as Strategic Games, Combinatorial Games, and Cooperative Games;
- Modeling and Analysis of Various Variants, Such as Repeated Games or Group Games;
- Solutions and Properties of Various Games, Such as Nash Equilibria, Pareto Efficiency, and Strategy Dominance

Focus on Statistics:

- Modeling stochastic processes and data collection under uncertainty;
- regression models (linear, generalized linear, logistic) and model selection;
- model quality metrics, validation, regularization, and overfitting prevention.

Practical examples from each area of focus are analyzed using formal models and solved using computer-aided methods.

Recommended reading:

- T.H. Cormen et al., Algorithmen, De Gruyter, Oldenburg, 2025.
- S.O. Krumke, H. Noltemeier, Graphentheoretische Konzepte und Algorithmen, Vieweg+Teubner, 2012.
- A. Heifetz, Game Theory: Interactive Strategies in Economics and Management, Cambridge Univ. Press, 2012.
- B. Auer, H. Rottmann, Statistik und Ökonometrie für Wirtschaftswissenschaftler, Springer Gabler, 2020. 23•
- J. Bleymüller, R. Weißbach, A. Dörre, Statistik für Wirtschaftswissenschaftler, Vahlen, München 2020.