LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Optimering och simulering
Operations Research - Basic Course

MIOF30, 6 credits, G2 (First Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED I
Date of Decision: 2023-04-14

General Information

Main field: Technology.
Compulsory for: I3
Elective for: M4-lp
Language of instruction: The course will be given in Swedish

Aim

The course has the overarching theme of optimization and simulation and aims to provide basic knowledge in deterministic and stochastic modelling of operational and managerial business problems.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to use basic optimization/math programming theory, queuing theory and methodology for discrete event simulation modelling, to analyse, and solve business problems relating to operational and managerial decisions.

For the *optimization/mathematical programming section* of the course this means:

- to be able to formulate linear and integer programming models and solve these using a commercial software (Excel).
- to be able to interpret solutions, results and sensitivity analysis obtained as output from the commercial software mentioned above.

- to be able to explain the theory behind the simplex method and to be able to use this method for solving linear programming problems (LP-problems).
- to be able to explain and use well known methods for sensitivity analysis of LP-problems.
- to be able to explain and use duality theory to analyse and solve LP-problems.
- to be able to explain and use basic "branch-and-bound" techniques for solving mixed integer programming problems (MIP).
- to be able to formulate optimization/math programming problems (LP and MIP) with several objective functions according to the techniques of goal programming.

For *the discrete event simulation section* of the course this means:

- to understand the principles of discrete event simulation modelling, and the opportunities and limitations this technique offers.
- to be able to use a commercial software (Extend) to create a simulation model and use this to analyse discrete event systems and processes.
- to be able to correctly use statistical methods to analyse input to, and output from simulation models, and to interpret the generated results. This involves the choice and fitting of distribution functions, as well as using various types of hypothesis testing methods.

For *the queuing section* of the course this means:

- to be able to formulate relevant business problems characterised by uncertainty in the availability and demand for capacity as queuing problems.
- to understand and explain principles for analytical modelling of basic queuing systems. The focus is on analysis of systems with exponentially distributed inter-arrival times and service times. However, it is also expected from the students to be able to analyse certain aspects of systems with generally distributed inter-arrival and service times.
- to be able to compute steady-state probability distributions of events as well as mean values of various performance measures as waiting times, queue lengths and costs.
- to be able to interpret the solutions and results obtained from the queuing models and place them in a business context.

Competences and skills
For a passing grade the student must

be able to independently formulate, solve and interpret:

- optimization/math programming models (LP, MIP, goal programming)
- queuing models (birth and death processes, M/M/c, M/M/c/K, M/M/c/¥/N, M/G/1)
- discrete event simulation models (modelled in the software Extend)

Furthermore, the student must be able to use established terms and unambiguously communicate problem formulation, solution and interpretation of optimization/math programming-, queuing- and discrete event simulation models. This ability is tested, for example, through three large group assignments that are solved independently by small

groups of students and documented in detailed technical reports.

Contents

In the optimization/math programming section of the course, the main concern is methods for linear and integer programming. The focus is on formulation, and interpretation of the results obtained when the formulated problems are solved using a commercial software. The purpose of using mathematical models to analyse decision problems is to provide the decision maker with a solid foundation for his actions. However, in order to use information produced by the models in a correct way requires an understanding for the underlying mathematics. Consequently, a significant part of the course is devoted to clarify basic mathematical methods used within the optimization/mathematical programming area. The section's mandatory project assignment is based on a case study describing a relatively complex business problem where an optimal decision is sought. By formulating and analysing an LP-model of the problem situation, a detailed decision proposal should be presented in a well structured technical report. Important assignment activities are: formulation of a relevant model, evaluation and optimization of the model using a commercial software, and interpretation and sensitivity analysis of the obtained results.

The simulation section of the course examines basic queuing theory as an analytical tool for analysing stochastic systems with relatively simple structure. To deal with more complex systems, a commercial software for discrete event simulation (Extend) is used. The developed models are used for analysing and improving production processes, and flow of materials and information. In order to arrive at a relevant simulation model, various types of stochastic events and processes must be characterised by appropriate distribution functions. Moreover, the output data from the simulation model must be analysed statistically in a correct way. Another important aspect is how to verify and validate the model to assure it is relevant and the results can be trusted. The section's mandatory project assignment is structured around a case study dealing with the analysis of a small production system using simulation models. The objective is to provide an understanding for the strengths and weaknesses with discrete event simulation models as a tool for process analysis. Each project group reports their assignment work and the obtained results in a well structured technical report.

The connections and integration of the optimization and simulation sections of the course are illustrated through a project assignment. This assignment is structured around a described business case, which should be analysed using both linear programming and simulation. An important objective is to bring forward the strengths and weaknesses with the different approaches, and the value of using them in an integrated fashion to analyse a typical production planning problem. Also in this assignment, each project group is required to document their work and their conclusions in a well structured technical report.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Individual written exam. For a passing grade it is required (in addition to a passing written exam) that mandatory assignments are completed. The assessment of the assignments is based on the technical reports turned in for grading. All reports need passing grades in order for the student to pass the course. The assignments are solved independently in groups of 2-4 students. Each group turn in one report per assignment.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0117. **Name:** Operations Research - Basic Course.
Credits: 6. **Grading scale:** TH.
Code: 0217. **Name:** Case.
Credits: 0. **Grading scale:** UG.

Admission

Assumed prior knowledge: MIO012/MIOA12/MIOA01 Managerial Economics, Basic Course Mathematical Statistics, Basic course (or equivalent) Linear Algebra (or equivalent).
The number of participants is limited to: No
The course overlaps following course/s: MIO310

Reading list

- Hillier F. S. and G. J. Lieberman, Introduction to Operations Research, latest edition, McGraw-Hill.
- Laguna M. and J. Marklund, Business Process Modeling, Simulation and Design, CRC Press latest edition.
- Course compendium.

Contact and other information

Course coordinator: Johan Marklund, johan.marklund@iml.lth.se
Course homepage: http://www.pm.lth.se
Further information: For further information please contact the Department of Production Management.