Elective Modules Operations and Supply Chain Management | Wahlfächer Operations and Supply Chain Management

WahlKat-OSCM: Catalogue of Elective Modules: Operations & Supply Chain Management | Wahlkatalog: Operations & Supply Chain Management

Module Description

WI200541: Planning and Scheduling of Complex Operations: Models, Methods and Applications | Planning and Scheduling of Complex Operations: Models, Methods and Applications

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Grading of the module will be based on the following four assessments: 1) At the end of the module the students have to take an open book written test of 60 minutes length. Through the course students have to hand in two assignments and have to make a 15 minute presentation followed by a 5 minute discussion. Taking the test the students show that they have understood the problems, models, methods and applications treated in the module. By undertaking the two assignments students demonstrate that they have acquired the capability of i) coding and implementing a scheduling approach by using a computer programming language (first assignment), and ii) implementing a scheduling optimization model by using a modelling language and a solver (second assignment). With the presentation students showcase their understanding and capability of presenting a scheduling application from the scientific literature so far not treated in the module. The assessments are weighted with 50% (test), 15% (coding assignment), 20% (optimization assignment) and 15% (presentation).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have knowledge in the mandatory undergraduate courses Mathematics (Linear Algebra), Statistics (probabilities, distributions), Management Science or Operations Research (Linear and Integer Programming), Production and Logistics or Operations Management, Programming, as well as a course in modelling and simulation such as in the elective undergraduate course “Modelling, Optimization and Simulation”.

Content:
Scheduling is about planning the timing of activities subject to scarce resources such as machines in order to fulfill an objective such as minimizing the flow time in the best possible way. Many scheduling problems in manufacturing and services are complex in the sense that there are precedence constraints enforcing minimum or maximum time lags between activities, more than one unit or type of scarce resource is required for processing an activity, capacity of resources is changing over time and complicated objective functions such as net present value have to be taken into account. The theory of resource-constrained project scheduling offers powerful modeling and solution techniques in order to address these kind of problems. The module empowers students to apply the main modeling and solutions concepts in order to successfully addressing real-world scheduling problems. The module is divided into four main parts which relate to different modelling concepts. Within each part the modelling concept, a linear programming formulations, heuristic and metaheuristic approaches as well as applications will be addressed. Next to its practical relevance, the module serves as a good starting point in order to undertake a master-thesis or a PhD-thesis.
• Scheduling activities with general precedence constraints
o Linear Program formulation
o Network flow algorithms for scheduling activities with general precedence constraints: Label correcting algorithm and Floyd-Warshall algorithm
o Applications
• Scheduling activities with renewable resource constraints: The Resource-constrained project scheduling problem
o Linear program formulations
o Special cases
o Heuristics and Metaheuristics
o Applications
• Scheduling activities with multiple modes, renewable and nonrenewable resource constraints: The Multi-mode resource-constrained project scheduling problem
o Linear program formulation
o Special cases
o Heuristics and metaheuristics
o Applications
• Scheduling activities with renewable resource constraints and stochastic durations: The stochastic resource-constrained project scheduling problem
o Heuristics and metaheuristics
o Applications

Intended Learning Outcomes:
Upon completion of the module students are empowered to analyze and optimize scheduling problems in services and manufacturing. In particular they 1) know the prevalent models and methods available in the literature. 2) They are capable of coding and implementing relevant algorithms. 3) They know how to model and solve linear programs in the field with off-the-shelf software. And 4) they understand and are able to present new approaches available in the scientific literature.

Teaching and Learning Methods:
The topics will be treated based on book chapters and papers in the scientific journals. Students are advised to prepare for the lecture by reading these material ahead of class. The content will be presented by the lecturer and discussed with the students. Then, students have to prepare applications of the approaches by solving small cases which will be discussed afterwards. The cases will be helping students to understand the problems addressed and the solution approaches provided. In order to empower students to implement the approaches in practice students will undertake two assignments. In the first assignment students implement an approach (exact procedure or heuristic) by using a programming language such as JAVA. In the second assignment students implement a linear programming model with the modelling language OPL and the solver CPLEX. The assignments will be provided at the beginning of the course giving students some time in order to undertake them . During the time of working at the assignments students can consult the teaching assistant in the exercise for help. In order to empower students to address problems not treated in class, students have to select and present a problem and an associated solution approach from the literature in class.

Media:
Slides, book chapters and papers, will be electronically made available in moodle.

Reading List:
• Brucker, P. and Knust, S. Complex Scheduling. GOR Publications. Springer, Berlin, 2. edition, 2012
• Schwindt, C. and Zimmermann J. editors. Handbook on Project Management and Scheduling Vol. 1. Springer, Heidelberg, 2015.
• Schwindt, C. and Zimmermann J. editors. Handbook on Project Management and Scheduling Vol. 1. Springer, Heidelberg, 2015.
• Neumann, K., Schwindt, C.and Zimmermann, J.. Project Scheduling with Time Windows and Scarce Resources. Springer, Heidelberg 2. edition, 2003.

Responsible for Module:
Kolisch, Rainer; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Complex Scheduling in Manufacturing and Services: Models, Methods and Applications (WI000541, englisch) (Limited places) (Vorlesung, 4 SWS)
Kolisch R, Ammann P

For further information in this module, please click campus.tum.de or here.

Module Description

CS0090: Advanced Seminar Operations & Supply Chain Management: Advances in Retail Management | Advanced Seminar Operations & Supply Chain Management: Advances in Retail Management

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a written seminar paper, implemented optimization or simulation models as well as an oral presentation & discussion. The seminar paper should cover 15-20 pages and is written in the style of current publications of peer-reviewed journal articles. Accompanied with the seminar paper models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. At the end of the module students present their work in a 45 minutes presentation. The written thesis and the presentation counts both with 50% of the final grading.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Prerequisite: One module in the field of Operations & Supply Chain Management and the MOS course.

Content:
The advanced seminar focuses on recent research progress on varying topics in service operations, e.g. omni-channel retailing, online retail management. Students identify strategic and operational relationships between supply chain management, marketing and service functions. Thereby, empirical research methods (such as regression models) are applied as well as mathematical optimization and simulation models (such as mixed-integer programming or discrete event simulation) to identify best practice relationships. Several topics with applications in assortment planning, last mile logistics, transportation, inventory management and procurement are available.

Intended Learning Outcomes:
The objective of the module is to equip the participants with the necessary skill and tools for a successful master thesis project.

Specifically, the aim is to be able to:

- Read and understand recent research contributions
- Pursue interesting research questions
- Conduct a literature study and/or numerical study and/or implementation
- Structure and organize research methods and results
- Write a seminar paper
- Present research findings and defend them in a discussion

Teaching and Learning Methods:
In an introductory session, the current theme of the module is explained by the lecturer and the various available seminar topics are elaborated in detail. Also information on relevant literature for the problem settings is introduced, wich forms the basis of the students' seminar papers. After the introductory session, students will work out the topic on their own, by using their abbilities of conducting literature research, mathematical modelling, programming and analyses. Throughout the whole time, they receive guidance from a supervisor of the chair. Different milestones are to be achieved at specific dates, such as a preliminary outline of the seminar paper, first research results and the final paper. Following the submission of the final paper, presentations and discussions of all students' seminar papers are conducted, usually spanning one or several days, where amongst others also presentation, moderation and discussion skills are trained.

Media:
Research paper; presentation slides

Reading List:
depending on scope of seminar, e.g., Hübner, A., Kuhn, H. & M.G. Sternbeck (2013): Retail demand and supply chain planning - An operations planning framework, in: International Journal of Retail and Distribution Management, 41 (7), S. 512–530

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

MGT001299: Introduction to Deep Reinforcement Learning | Introduction to Deep Reinforcement Learning

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The overall grading bases on a written exam (120 minutes) that consists of a multiple-choice part (50%) and open questions (50%). In the multiple-choice part, students have to answer methodological questions and demonstrate that they understood the theoretical content of the course. In the open questions, the students apply the gained knowledge to practical questions and exercises, e.g., by developing specific algorithmic components. By so doing, the students have to show that they can transfer the gained knowledge to practical problems and can apply deep learning algorithms to solve analytics and business problems in practice.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
To successfully attend this course, students should be comfortable with math-centric content, algorithms, and proofs. Students should have a general understanding of:
• basic linear algebra, including for example matrix multiplication and matrix-vector multiplication
• multivariate calculus, including for example partial derivatives, the chain rule, and gradients
• basic stochastics, including for example discrete and continuous random variables and probability distributions, as well as the notions of expectation and variance
• basics of mathematical optimization, including for example constrained optimization problems and the notion of convergence
For the programming exercises, which are a part of this course and its exam, we use the Python programming language and the NumPy library. Thus, students should ideally be familiar with Python. Alternatively, knowledge of a general purpose programming language (e.g., C++, Java) or Matlab is sufficient as well, as students will be able to adapt to Python very quickly.

Content:
The module content covers the theory of Deep Reinforcement Learning and required fundamentals. Specifically, topics include but are not limited to:
- fundamentals (e.g., stochastic gradient descent, logistic regression, artificial neural networks)
- Deep Q-Networks and Rainbow DQNs
- policy gradients, trust region policy optimization, proximal policy optimization
- actor critic methods, soft actor critic methods
- applied case studies

Intended Learning Outcomes:
After attending this course, students will have acquired …
… basic knowledge in the domain of search algorithms, e.g., graph and tree search, and understand the fundamental theory behind it
... the competence/capability to analyze a practical problem by modelling it as a Markov Decision Process (MDP)
… profound knowledge in the domain of reinforcement learning and understanding of fundamental reinforcement learning theory, e.g., Q-learning, TD learning
… basic knowledge in deep learning and understanding of fundamental machine learning and deep learning theory, e.g., stochastic gradient descent, logistic regression, artificial neural networks
… profound knowledge in the domain of deep reinforcement learning (DRL) that combines the previous two competence areas and understanding of fundamental DRL theory, e.g., deep Q-networks (DQN), advanced policy gradient methods such as proximal policy optimization (PPO)
… the competence/capability to apply a DRL framework to a practical problem
… the competence/capability to evaluate DRL methods w.r.t. to advantages and disadvantages
… the competence/capability to evaluate practical applications w.r.t. typical pitfalls (e.g., convergence issues with non-independent samples) when using DRL and how to circumvent them

Teaching and Learning Methods:
Students learn the theory behind deep reinforcement learning in lectures. In additional exercises and coding labs, students learn how to apply this knowledge to practical problems.

Media:
slides, readings, exercises, coding labs

Reading List:
Sutton, R. S., & Barto, A. G. (2018). Reinforcement learning: An introduction. MIT press.
Bengio, Y., Goodfellow, I., & Courville, A. (2017). Deep learning. MIT press.
Russell, S., & Norvig, P. (2010). Artificial Intelligence: A Modern Approach. Prentice Hall.

Responsible for Module:
Schiffer, Maximilian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Deep Reinforcement Learning (MGT001299, englisch) (Vorlesung, 2 SWS)

Schiffer M, Nouli G, Hoppe H

Introduction to Deep Reinforcement Learning (MGT001299, englisch) (Exercise) (Übung, 2 SWS)
Schiffer M, Nouli G, Hoppe H
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001306: Planning and Scheduling in the Automotive Industry | Planning and Scheduling in the Automotive Industry

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The assessment takes place in form of a written exam (120 min) at the end of the semester.
In the exam students demonstrate that they are able to explain, discuss and critically evaluate specific concepts of operations and supply chain management in the automotive industry. Furthermore, they proof that they can apply the discussed quantitative approaches and assess these approaches in terms of effectiveness and efficiency.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Operations Research and Higher Mathematics

Content:
With practical examples from the automotive industry, the course expands the participants' ability to apply quantitative methods for operational problems. Planning systems in the automotive industry are demonstrated using real examples and problem sizes. The relationships between planning problems and the associated coordination concepts (e.g. hierarchical planning, rolling planning, event-driven) are presented. The implementation of mass customization, strategies for variety reduction, layout and assembly line, sequencing, production program planning, strategic allocation of products to plants and production lines are shown. The course shows the connection between strategic and operational tasks using the latest mathematical modeling for digital production planning. You will learn the introduced methods are applied in modern modeling software (CPLEX, R and Python KI libraries).

Practical cases

Ramp-up planning for new product introduction in a global production network, MRP for high variety premium production, Exploring the power of option bundling, Aggregate planning and the impact of pricing and capacity planning, Capacity fixing for body-shop planning

Methodologies
Mixed integer programming for strategic network optimization; Bayesian forecasting, AI-based data fusion and deep learning with neural networks for MRP; Constraint programming for car sequencing.

Intended Learning Outcomes:
• Gain an overview and insights on different manufacturing environments for automotive production and supply chain management
• Understand modelling strategies to match customer demand and automotive order-to-delivery processes in a flexible production network
• Describe and Link product variety to order-fulfillment strategies and understand the impact of product variety on operations
• Define Mass customization strategies and their function in different production scenarios
• Apply Bayesian forecasting techniques, AI and deep learning models to real-world cases and apply forecast error measurement systems
• Understand optimization techniques for manufacturing operations planning and balance production loads with linear programming
• Use stochastic models for uncertain data and planning situations
• Be able to calculate complex product launch and ramp-up scenarios for automotive production and understand the Management of the Operations Interfaces
• Define and apply Material Requirements planning for automotive components and understand the sourcing cost structure and supplier cascade in this industry
• Understand the concept of Assembly Lines and be able to apply balancing and sequencing OR approaches.

Teaching and Learning Methods:
The module consists of lectures with integrated exercises.
In the lectures the contents of the module are delivered through presentations and talks. In the integrated exercises students apply their knowledge to solve case assignments. The results are then discussed in class. The students improve the acquired knowledge by studying the suggested literature.

Media:

Reading List:
· Staeblein, T., & Aoki, K. (2015). Planning and scheduling in the automotive industry: A comparison of industrial practice at German and Japanese makers. International Journal of Production Economics, 162, 258-272.

· Becker, A., Stolletz, R., & Stäblein, T. (2017). Strategic ramp-up planning in automotive production networks. International Journal of Production Research, 55(1), 59-78.
· Wochner, S., Grunow, M., Staeblein, T., & Stolletz, R. (2016). Planning for ramp-ups and new product introductions in the automotive industry: Extending sales and operations planning. International Journal of Production Economics, 182, 372-383.
· Bersch, C. V., Akkerman, R., & Kolisch, R. (2021). Strategic Planning of New Product Introductions: Integrated Planning of Products and Modules in the Automotive Industry. Omega, 102515.
· Song, J. S., & Xue, Z. (2021). Demand shaping through bundling and product configuration: A dynamic multiproduct inventory-pricing model. Operations Research, 69(2), 525-544.
· Meyr, Herbert. "Supply chain planning in the German automotive industry." In Supply Chain Planning, pp. 343-365. Springer, Berlin, Heidelberg, 2009.
· Wu, J., Ding, Y., & Shi, L. (2021). Mathematical modeling and heuristic approaches for a multi-stage car sequencing problem. Computers & Industrial Engineering, 152.

Responsible for Module:
Grunow, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Planning and Scheduling in the Automotive Industry (MGT001306, englisch) (Vorlesung, 4 SWS)
Grunow M [L], Okumusoglu B, Stäblein T
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001307: Data Analytics in Applications | Data Analytics in Applications

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 140	**Contact Hours:** 40

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
As part of the seminar, students are given a Data Challenge from companies with real world data - a unique opportunity to work "hands-on" on a data analytics project in an interdisciplinary way.

Students apply their theoretical knowledge to this real project and work on the challenge. The module grade is composed of the seminar paper evaluation (90%) and a final presentation (10%). The submission of the seminar paper includes the documentation of the developed solutions as well as the commented out program code (python) in digital form. The duration of the final presentation is 30 minutes. The assignment will be done in teamwork.

The mentors of the Data Challenge will also be present at the presentation - the best groups will receive a prize and the opportunity to get in closer contact with excellent companies.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic programming knowledge is required. In the course there will be short sessions on selected models as review, as well as on data preprocessing & modeling with python.

Students without programming experience can qualify for the course, by working out the gaps in advance.

Upon successful completion, students receive a certificate.

Content:
The module consists of two sub-modules: In the first sub-module, the necessary theoretical basics are taught in the form of seminars and exercises. Exemplary use cases are presented and the methodology for processing data analytics use cases is taught. In the second submodule, students work on a self-identified or specified use case. Support will be provided in the form of consultation hours.

The seminar takes place in cooperation with the TUM KI-Lab, which consists of a consortium of well-known representatives from industry. The cooperation partners provide possible use cases, data sources and contact persons, so that the seminar has a strong practical character. In addition, exclusive insights into the data analytics applications of the cooperation partners are provided through guest lectures. Students will have the opportunity to establish valuable industry contacts.

Contents:
- CRISP-DM & ML-Ops
- Business Understanding for Data Analytics
- Data Understanding & Data Preperation (+exercise)
- Modeling (Descriptive Analytics, Classification, Clustering, Regression) (+exercise)
- Evaluation of ML-Models
- Deployment of ML-Models

Students of the seminar have the unique opportunity to participate on-site at the Munich Management Colloquium and receive free tickets to this event.

Intended Learning Outcomes:
After completing the seminar, students will be able to identify data analytics projects in a structured way, work on them independently and implement them (via python and from a management perspective). The seminar promotes interdisciplinary group work, offers students the opportunity to learn with and from each other, and also provides students with the unique opportunity to work on a concrete, real-world data project. Students can apply their theoretical knowledge and programming skills in practice. The "learning-by-doing" concept, applied to a data challenge of a partner company of our AI Lab is the focus of this seminar and promises excellent learning experiences.

Students learn: (i) the identification of valuable and practical data analytics use cases, (ii) the structured project planning of programming tasks as well as the processing of a data analytics use case in a team using state-of-the art software, (iii) the targeted compilation of results and program code. In addition, the students learn in a kind of hackathon (Data Challenge) over 2 months the structured implementation of a Proof of Concepts (PoC) via python in a team (iv). The seminar is based on the CRISP-DM process (v). The Data Challenge is intentionally designed to be very open in order to challenge and encourage the creativity and initiative of the students (vi) with regard to business case and value proposition.

Teaching and Learning Methods:
The module consists of 4 seminar units of 4 hours each including exercises in the form of Jupyter notebooks (python). This is followed by independent work on a data project in teamwork. Consultation hours are available for support during the team project.

Media:

Reading List:
Applied Data Mining for Business Analytics - Dursun Delen
Learning Python: Powerful Object-Oriented Programming - Mark Lutz
Machine Learning mit Python und Keras, TensorFlow 2 und Scikit-learn: Das umfassende Praxis-Handbuch für Data Science, Deep Learning und Predictive Analytics (mitp Professional) - Sebastian Raschka

Responsible for Module:
Wildemann, Horst; Prof. Dr. Dr. h.c. mult.

Courses (Type of course, Weekly hours per semester), Instructor:
Data Analytics in Applications (MGT001307, englisch) (Seminar, 4 SWS)
Blümelhuber B, Junker S, Stepanek N
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001350: Advanced Seminar Operations & Supply Chain Management: Production & Supply Chain Management | Advanced Seminar Operations & Supply Chain Management: Production & Supply Chain Management

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students write a research paper (max. 25 pages) relating to a specific topic within the focus of the module, in which they demonstrate that they can perform a small research project from a discussion of the relevant literature, analysis of problem and solution approaches to the application in examples or cases and the identification of directions for future research. A final presentation (30 minutes with ensuing Q&A) proves that students are able to present their work to a scientific audience in a precise, comprehensible and demonstrative way. Further information will be announced at the beginning of the semester.
Research paper and presentation will be graded as one contribution/examination, individual weighting is not applicable.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
It is expected that participants have an interest in practical problems of production planning, scheduling and logistics, and the quantitative modelling of business problems. Participants should be familiar with Operations Research (OR) techniques.

The modules "Management Science" and "Production and Logistics" or similar modules at other universitites are a prerequisite.

It is strongly advised that the participants have previously taken part in the module "Modelling, Optimization and Simulation in Operations Management" or similar modules at other universities.

Content:
Within this seminar, groups of students study a variety of problems with real-world applications.
A supervisor with relevant research background guides each group through every step of their progress, from understanding the state-of-the-art literature to the final implementation of their extensions. Using selected scientific publications, the students will understand problems relevant to different industries and investigate various modeling and solution techniques to solve these problems.
Within this process, students develop a wide spectrum of skills, which ultimately prepares them for carrying out a thesis with high academic value.

Intended Learning Outcomes:
At the end of the module the students will be able to:
- Review state-of-the-art in operations and supply chain management approaches related to the module focus.
- Apply literature findings and/or methodologies to examples or case studies.
- Critically evaluate the scientific contributions of the analyzed literature.
- Analyze problems and solution approaches for operations and supply chain management methods and tools in the context of the module focus.
- Develop ideas for future research in relation to the seminar focus.
- Adequately communicate and discuss scientific contributions and research findings within the focus of the module

Teaching and Learning Methods:

The module consists of a seminar. The contents is delivered through presentations by the students. The students improve the acquired knowledge by studying the suggested literature. The students will be supervised by the lecturer when they work on their topic.

Media:

Presentation slides
Technical papers

Reading List:

van Weele, Arjan J., Purchasing and Supply Chain Management, 2014

Research papers

Responsible for Module:
Grunow, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

MGT001370: Designing Manufacturing Systems | Designing Manufacturing Systems

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students demonstrate that they can create appropriate designs for different production systems using the approaches introduced in the lecture. Furthermore, students show that they are able to explain the fundamentals of the different design approaches and evaluate them. At the end of the lecture students will have a good understanding of the design of production systems and layouts, like job shops, flow lines, single flow rows, production centers, and flexible assembly layouts.

3 assignments (50%) and a written test (50%). Each assignment consists of 4–5 questions, with the points equally distributed among the assignments, i.e., each assignment is worth 30 points (90 points in total). Similarly, the written test is also worth 90 points.

Allowed aids for the test will be announced at the beginning of the semester.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
PLEASE NOTE:
This module cannot be attended if WI100967 Designing and Scheduling Manufacturing Systems was attended previously.
Knowledge of quantitative approaches to production and supply chain management. The modules "Management Science” and “Production and Logistics” or similar modules at other universities are a prerequisite. Also, basic programming experience in Python is strongly recommended.

Content:
Decisions related to designing of a production system play an important role in all manufacturing industries. Decisions like configuration of a layout and planning of material flow are all essential for maximizing the profit of a company. In this course, the students learn how to support these decisions by applying various quantitative methods in application areas such as assembly systems, process industries, automotive industry and AGVs in flexible assembly layouts and production centers.

Content:
• Layout types
• Job shops
• Single flow row
• Traditional assembly lines
• Flexible assembly lines
• Production systems under uncertainty

Intended Learning Outcomes:
After the module the students will be able to:
• Give an overview of methods used in designing production systems.
• Distinguish the most important production layout types (job shop, flow lines and production centers). Analyze the
layout types advantages and disadvantages, decide for practical layout problems, which type to choose.
• Apply rough and exact planning approaches for the most important layout types, including the application of
heuristics and the formulation and adaption of mathematical models.

Teaching and Learning Methods:
The module uses a blended learning approach with online on-demand lectures for the students to study on their own pace. Weekly in-class lectures are intended to re-cap the lecture material from the recorded videos, clarify questions and discuss extensions. The optional assignments involve the modelling of the design problems discussed in class and the implementation of these mathematical models.

Media:
Lecture slides, lecture video recordings and case studies, in-class exercises, homework assignments and their solutions.

Reading List:
Books

Cachon, G., Terwiesch, C., Matching Supply with Demand: An Introduction to Operations Management, Fourth edition, McGraw-Hill, 2019, ISBN: 9781260084610

Günther, H.-O., Tempelmeier, H., Supply Chain Analytics, 13th edition, Springer, 2020, ISBN: 9783750437661

Heragu, S. S., Facilities Design, Fourth edition, CRC Press, 2016, ISBN: 9781498732895

Hopp, W. J., Spearman, M. L., Factory Physics, Third edition, Waveland Press, 2011, ISBN: 1577667395, 9781577667391

Williams, H. P., Model building in mathematical programming, Fifth edition, Wiley, 2013

General papers

Benjafaar, S., Heragu, S. S., Irani, S. A., Next generation factory layouts: research challenges and recent progress, Interfaces, 32(6), 2002, 58-76

Singh, S. P., Sharma, R. R. K., A review of different approaches to the facility layout problems, International Journal of Advanced Manufacturing Technology, 2006, 30 (5-6), 425-433

Drira A., Pierreval H., Hajri-Gabouj S., Facility layout problems: A survey, Annual Reviews in Control, 31 (2), 2007, 255-267

Job shops

Heragu, S. S., Kusiak, A., Efficient models for the facility layout problem, European Journal of Operational Research, 53 (1), 1991, 1-13

Single row flow

Ho, Y.C., Moodie, C.L., Machine layout with a linear single row flow path in an automated manufacturing system, Journal of Manufacturing Systems, 17(1), 1998, 1-22

Flow systems design

Higle, J. L., Stochastic Programming: Optimization When Uncertainty Matters. INFORMS, 30–53, 2005

Sundaramoorthy A, Evans JMB, Barton PI (2012) Capacity Planning under Clinical Trials Uncertainty in Continuous Pharmaceutical Manufacturing, 1. Mathematical Framework. Industrial & Engineering Chemistry Research 51(42):13692–13702.

Stefansdottir, B., Grunow, M., Selecting new product designs and processing technologies under uncertainty: Two-stage stochastic model and application to a food supply chain. International Journal of Production Economics 201 89–101, 2018

Assembly lines

Boysen, N., Fliedner, M, Scholl, A., Assembly line balancing: Which model to use when?, International Journal of Production Economics, 111 (2), 2008, 509-528

Scholl, A., Becker, C., State of the art exact and heuristic solution procedures for simple assembly line balancing, EJOR; 168, 2006, 666- 693. (excluding sections 3.3-3.5, 4.2, 4.3, 5.2, 5.3)

Becker, C., Scholl, A.: A survey on problems and methods in generalized assembly line balancing, European Journal of OperationsResearch. 168, 2006, 694-715

Gökcen, H., Erel, E., Binary integer formulation of mixed-model assembly line problem, Computers and Industrial Engineeing, 34, 1998,451-461

Flexible Assembly Layouts

Hottenrott, A., Grunow, M., Flexible layouts for the mixed-model assembly of heterogeneous vehicles, OR Spectrum, 41, 2019, 943-979

Responsible for Module:
Grunow, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Designing Manufacturing Systems(MGT001370, englisch) (Vorlesung, 4 SWS)
Grunow M, Okumusoglu B
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001371: Scheduling Manufacturing Systems | Scheduling Manufacturing Systems

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The focus is on scheduling short term operations on the different manufacturing layout types.
The students have to show that for different production systems they are able to apply suitable scheduling approaches taught in the lecture.
Furthermore, the students demonstrate that they are able to explain the fundamentals of the different scheduling approaches and evaluate them.

3 assignments (50%) and a written test (50%). Each assignment consists of 4–5 questions, with the points equally distributed among the assignments, i.e., each assignment is worth 30 points (90 points in total). Similarly, the written test is also worth 90 points.

Allowed aids for the test will be announced at the beginning of the semester.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
PLEASE NOTE:
This module cannot be attended if WI100967 Designing and Scheduling Manufacturing Systems was attended previously.
Knowledge of quantitative approaches to production and supply chain management. The modules "Management Science” and “Production and Logistics” or similar modules at other universities are a prerequisite. Also, basic programming experience in Python is strongly recommended.

Content:
Decisions related to scheduling of a production system play an important role in all manufacturing industries. Decisions like configuration of a layout and planning of material flow are all essential

for maximizing the profit of a company. In this course, the students learn how to support these decisions by applying various quantitative methods in application areas such as assembly systems, process industries, automotive industry and AGVs in flexible assembly layouts and production centers.

Content:
• Layout types
• Introduction to scheduling
• Job shops
• Flexible assembly systems
• Economic lot scheduling, block planning
• Scheduling AGV‘s in centers (online vs. offline scheduling)

Intended Learning Outcomes:
After the module the students will be able to:
• Give an overview of methods used in scheduling production systems.
• Give an overview of the scheduling objectives and requirements in manufacturing.
• Evaluate and apply different planning procedures (shifting bottleneck, scheduling of flexible assembly systems,
economic lot scheduling, block planning and online vs. offline scheduling) to develop production schedules for
different types of systems such as assembly lines, food processing systems and AGVs in flexible assembly layouts
and production centers.
• Apply heuristics and formulate and solve mathematical models

Teaching and Learning Methods:
The module uses a blended learning approach with online on-demand lectures for the students to study on their own
pace. Weekly in-class lectures are intended to re-cap the lecture material from the recorded videos, clarify questions and discuss extensions. The assignments involve the modelling of the scheduling problems discussed in class and the implementation of these mathematical models.

Media:
Lecture slides, lecture video recordings and case studies, in-class exercises, homework assignments and their solutions.

Reading List:
Books
Pinedo, M., Planning and Scheduling in Manufacturing and Services, Second edition, Springer, 2009, ISBN: 978-1-4419-0909-1, e-ISBN 978-1-4419-0910
Williams, H. P., Model building in mathematical programming, Fifth edition, Wiley, 2013

Paced assembly systems

Boysen, N., Fliedner, M., Scholl, A., Sequencing mixed-model assembly lines: Survey, classification and model critique. European Journal of Operational Research, 192 (2), 2009, 349–373.
Boysen, N.; Fliedner, M., Comments on “Solving real car sequencing problems with ant colony optimization”. European Journal of Operational Research 182 (1), 2007, 466–468.
Gagné, C., Gravel, M., Price, W. L., Solving real car sequencing problems with ant colony optimization, European Journal of Operational Research, 174(3), 2006, 1427-1448
Solnon, C., Cung, V.D., Nguyen, A., Artigues, C., The car sequencing problem: Overview of state-of-the-art methods and industrial case-study of the ROADEF’2005 challenge problem, European Journal of Operational Research 191(3), 2008, 912-927.

Block planning
Günther, H.O., An application of MILP-based block planning in the chemical industry, Proceedings of the Eighth International Symposium on Operations Research and Its Applications (ISORA’09), Zhangjiajie, China, September 20–22, 2009, 103–110. Günther, H.O., The blockplanning approach for continuous time-based dynamic lot sizing and scheduling, Business Research, published online 2014
Kilic, O. A., Akkerman, R., van Donk, D. P., & Grunow, M. (2013). Intermediate product selection and blending in the food processing industry. International Journal of Production Research, 51(1), 26–42.
Lütke-Entrup, M., Günther, H.O., van Beek, P., Grunow, M., Seiler, T., Mixed integer linear programming approaches to shelf-life integrated planning and scheduling in yogurt production, International Journal for Production Research, 43(23), 2005, 5071-5100.

Flow lines
Stefansdottir, B., Grunow, M., Classifying and modeling setups and cleanings in lot sizing and scheduling, European Journal of Operational Research, 216(3), 2017, 849-865

Responsible for Module:
Grunow, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Scheduling Manufacturing Systems (MGT001371, englisch) (Vorlesung, 4 SWS)
Grunow M, Dörr J, Okumusoglu B, Schömig-Beißner M
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001389: Coding Lab: Deep Reinforcement Learning | Coding Lab: Deep Reinforcement Learning

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grading consists of i) a presentation (30%) and ii) a seminar paper (70%) and allows to value the two main learning objectives of this seminar i) presenting and discussing recent and own research and ii) conducting and documenting research in a written form.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Introduction to Deep Reinforcement Learning (mandatory requirement)

Content:
Deep Reinforcement Learning has recently evolved as a vivid field of research that seeps into various industries and applications. In this seminar, we build on the theoretical foundations that we learned in the course "Introduction to Deep Reinforcement Learning" and study a real-world application case in order to understand how to design and implement advanced DRL algorithms to solve use cases of practical interest.

Intended Learning Outcomes:
The objective of this seminar is to provide the students with the necessary skills to conduct independent research in the field of Deep Reinforcement Learning, e.g., in preparation for a successful master thesis or a research stay abroad. Herein, students learn how to i) structure a research question and conduct a literature review, ii) use and develop adequate models, software, and algorithms to solve the research question, iii) write a research paper, especially how to structure and organize results and the corresponding methodology, and iv) work in an academic environment where knwoledge is mostly gained from recent papers and less from standardized books.

Teaching and Learning Methods:
This seminar bases on various methods: First, the lecturer gives an introduction into the general topic and an overview on recent trends and challenges in an introductory session. Afterward, a case study based on a real-world applicaiton is introduced. Then, students will work in small groups on this case study, using and practicing their skills in literature research, mathematical modeling, and programming. During this phase, the students receive weekly guidance and feedback from the lecturer. Furthermore, this work phase is structured through specific milestones, e.g., discussing a preliminary outline, first results, and main findings. Finally, the students create a final paper on their work and presentations as well as discussions of all papers take place such that the students reflect their work and train their presentation skills.

Media:
Presentations, varying forms of literature, inverted classroom

Reading List:
Sutton, R. S., & Barto, A. G. (2018). Reinforcement learning: An introduction. MIT press.
Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT press.
Additional readings will be announced in class

Responsible for Module:
Schiffer, Maximilian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Coding Lab: Deep Reinforcement Learning (MGT001389, englisch) (Limited places) (Seminar, 4 SWS)
Schiffer M, Deng S, Jungel K
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001448: Advanced Seminar Operations & Supply Chain Management: Online Scheduling Case Challenge | Advanced Seminar Operations & Supply Chain Management: Online Scheduling Case Challenge

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students' solution approaches for the course's case challenge are evaluated. The quality of their solution approach determines 40% of the student's grade.

Students write a report based on their solution approach for the course's case challenge. The report constitutes 40% of their final grade. The quality of the research, as well as the scientific writing of the report, are considered in grading.

For the remaining 20% of the grade, students deliver a scientific presentation based on the report at the end of the semester, including a Q&A.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Previous participation in the modules "Scheduling Manufacturing Systems ", "Management Science," “Production and Logistics,” and "Modelling, Optimization, and Simulation in Operations Management" or similar modules at other universities are reommended.

Basic programming skills (e.g., OPL, CPLEX, C++, Python), knowledge and experience with mathematical modeling and simulation are the requirements of the course.

Finally, we emphasize that students should be interested in online scheduling problems, as it is the case study of the course.

Content:
Groups of students work on an online scheduling problem in the form of a case study.
Students are presented with raw data that describes the parameters of the problem.
A plethora of OR and Machine Learning (ML) approaches exist that can be alternatively applied to the case study problem. Accordingly, there will be several lectures to provide students with a broad overview of these approaches. However, students can choose any OR and ML approach they prefer to tackle the problem. Students are encouraged to delve into the existing literature on the problem. This will not only provide them with more ideas on how to model and solve the problem, but also enhance their understanding of the theoretical underpinnings of the OR and ML approaches they will be using.
There will be additional lectures on how to appropriately write a scientific report.
To increase student engagement, there will also be a competition among the students. The winning team wins a prize as well as a certificate.

Intended Learning Outcomes:
Due to the competition embedded in the course, students learn and implement state-of-the-art solution approaches for the course's online scheduling case challenge. This, in turn, gives them a deep understanding of online problems and equips them with a potent skill set that applies to many similar problems with large relevance for the industry.
In developing their solution approach, students learn to critically evaluate different modeling approaches for the problem. By the end of the course, they have a strong judgment of the approaches relevant to online problems.
As students work with real-world problem-specific data, students will learn the preparation steps required to turn raw data into relevant model parameters.
Students will be able to prepare a scientific report accodring to academic standards and learn how to effectively communicate their findings with their peers.

Teaching and Learning Methods:
To boost students' learning and encourage them to use state-of-the-art solution approaches for the course's case challenge, a competition is embedded in the course. The winning team wins a prize as well as a certificate.
The course's case challenge is an online scheduling problem with real-world relevance. Raw data will be provided to the students, and they will take steps to extract relevant model parameters.
During several lectures, students gain a broad understanding of the various OR and ML approaches that can be applied to online problems in general. Furthermore, in a separate lecture, they learn how to appropriately write a scientific report.
At the mid-term and final presentations, students will have the opportunity to present their work. These presentations provide students with comprehensive feedback on the quality of their work, along with guidance on areas for improvement.

Media:
Moodle

Reading List:
Pinedo, M.L. (2022), Scheduling: Theory, Algorithms, and Systems. Springer, 6th Edition. Available at: https://doi.org/10.1007/978-3-031-05921-6

Responsible for Module:
Grunow, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Operations & Supply Chain Management (MGT001448, englisch): Online Scheduling Case Challenge (Seminar, 4 SWS)
Dörr J, Fatemianaraki S, Grunow M
For further information in this module, please click campus.tum.de or here.

Module Description

WIB09828_2: Advanced Seminar Operations & Supply Chain Management: Operations Management | Advanced Seminar Operations & Supply Chain Management: Operations Management

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Grading is based on a seminar paper, the presentation of the respective paper as well as on active class participation. The seminar paper as well as the class participation should proof the student's acquired knowledge about the respective research topic. Furthermore, they should show whether the student managed to critically analyze the key aspects regarding their research question. By presenting their findings in front of the class, students proof that they are able to present the key aspects in a concise manner and that they are able to answer further questions on their presented findings. The seminar paper accounts for 60% of the overall grade. The presentation and participation in the discussions account for 40% of the overall grade.

Repeat Examination:

(Recommended) Prerequisites:
WI000275 "Management Science",
MA9712 "Statistik",
WI000226 "Service Operations Management"
WI000974, WI001088, "Modeling and Optimization in Operations Management"
WI000974, WI01088, "Simulation and Optimization in Operations Management"

Content:
This seminar will treat selected topics from the area of Operations Management. Operations Management is the planning and controlling of work flows. Thus, Operations Management is a central aspect of management.

Intended Learning Outcomes:
At the end of the module the students are able to understand the approaches to tackle several several operations management problems. The students are able to implement such procedures and can assess these approaches in term of effectiveness and efficiency. Finally, they are able to make sound decisions. Furthermore, the students are able to create, based on scientific publication, an independent elaboration which fulfils the formal requirements of a scientific work.

Teaching and Learning Methods:
The module consists of a seminar. The content is delivered thru presentations. The students are inspired to improve the acquired knowledge by studying the suggested literature. The students are encouraged to self practice outside the classroom. Results are presented and discussed in class. Students are supervised when they work on the several topics.

Media:
presentation slides

Reading List:
Selected literature based on the topic

Responsible for Module:
Kolisch, Rainer; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Operations & Supply Chain Management (WIB09828_2, englisch): Operations Management (limited places) (Seminar, 4 SWS)
Kolisch R, Kolter M
For further information in this module, please click campus.tum.de or here.

Module Description

WIB22001: Sustainable Supply Chain Management | Sustainable Supply Chain Management

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grading is based on written assignments (40%) and a presentation (40%) including discussion (20%). Throughout the module students present main findings of current journal articles in a presentation and participate in the following discussion with their fellow participants.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The course does not require any specific prior knowledge. Some basic knowledge in Excel is sufficient.

Content:
In this course we will deal with the topic of sustainability in supply chains. The three pillars of sustainability (economic, social, environmental) are seen as a cornerstone for today's businesses. In this course the students will learn some important concepts of sustainability such as closing the loop or circular economy as well as systems thinking or life cycle analysis. It starts with an introduction into the basics and fundamental concepts of sustainability in operations and supply chain management. We will discuss how these concepts can be transferred to certain key performance indicators. The reporting standards of the Global Reporting Initiative are then used to discuss the contents of sustainability reports. During the course we will also have a look how to incorporate sustainability concepts into decision models in the context of supply chain management, especially location decisions and routing decisions. Students will moreover discuss current issues (like humanitarian supply chain topics, corporate social responsibility issues etc.) in sustainable supply chain management based on recent journal papers.

Intended Learning Outcomes:
After participating in this module, participants will have gained knowledge about different concepts in sustainable supply chains and received the knowledge to apply decision support in this field. Furthermore, this course will shape students' opinion on sustainability issues and provide them with the bigger picture on causes and effects of global supply chain management. Through the written assignments and the presentations, students further improve their skills of academic writing, improve their presentation skills and carrying out discussions within a research environment.

Teaching and Learning Methods:
The course consists of lectures and assignments where students obtain knowledge about the field of sustainability in supply chain management. Additionally, students are required to read relevant literature in preparation for the class, are stimulated to deal with this subject deeper and prepare presentations on current topics for the class. A short paper discussion and presentation (group work) provides participants the opportunity to specialize on a recent topic.

Media:
- Literature (journal articles, selected chapters of textbooks)
- Assignments and discussion of Assignments in class
- Examples and case studies for problem-based learning
- Business game(s)

Reading List:
Teaching contents are based on (selected chapters of) text books and journal articles such as, for instance,
• Chopra, S., Meindl, P. (2010) Supply Chain Management, 4th edition, Prentice Hall.
• Cachon, G., Terwiesch, C. (2011) Matching Supply with Demand, 3rd edition, McGraw-Hill.
• Van Weele, A.J. (2010) Purchasing and Supply Chain Management, 5th edition, Cengage.
• Van Mieghem (2008) Operations Strategy: Practices and Principles, Dynamic Ideas.
• Piecyk, M., Browne, M., Whiteing, A., & McKinnon, A. (Eds.). (2015) Green logistics: Improving the environmental sustainability of logistics. Kogan Page.
• Grant, D.B., Trautrims, A., Wong, C.Y. (Eds.) (2017) Sustainable Logistics and Supply Chain Management: Principles and Practices for Sustainable Operations and Management, 2nd edition, Kogan Page.
• Souza, G. C. (2013) Closed-loop supply chains: a critical review, and future research. Decision Sciences 44 (1), 7–38.
• Srivastava, S. K. (2007) Green supply-chain management: a state-of-the-art literature review. International Journal of Management Reviews 9 (1), 53–80.
• Allon G., Van Mieghem J.A. (2010), Global Dual Sourcing: Tailored Base-Surge Allocation to Near- and Offshore Production, Management Science 56, pp. 110-124.
Detailed literature for every lecture will then be provided in the syllabus.

Responsible for Module:
Minner, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainable Supply Chain Management (WIB22001, englisch) (Limited places) (Vorlesung mit integrierten Übungen, 4 SWS)
Minner S [L], Bloemer A
For further information in this module, please click campus.tum.de or here.

Module Description

WIB22964: Advanced Seminar Operations & Supply Chain Management: Logistics and Supply Chain Management | Advanced Seminar Operations & Supply Chain Management: Logistics and Supply Chain Management

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a written seminar paper including implemented optimization or simulation models (75%), an oral presentation (20%) and a discussion (5%). The seminar paper to be submitted one week prior to the presentation should cover 15-20 pages and is to be written in the style of current publications of peer-reviewed journal articles, including an introduction, a literature review, a description of the model and algorithms, numerical results and conclusions to show the competencies to clearly describe a research problems, the ability to conduct a literature view, to structure the material and demonstrate technical writing, design an experiment and describe and visualize the results, and show the ability to critically discuss the results. At the end of the module, students present their work in a 30 minutes presentation to the chair members and other seminar participants to show the ability to design and deliver a research presentation using different available media and visualization tools and defend the results in a critical group discussion. In the discussion part, every student has to read and summarize the paper and presentation of one other participant to demonstrate the ability to summarize and moderate a research discussion with all other seminar participants.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
One module in the field of Operations & Supply Chain Management and the MOS course.

Content:
The advanced seminar in logistics and supply chain management focuses on recent research progress on varying topics, e.g. supply chain performance measurement, metamodelling and metaheuristics (see below for example).

- Metamodelling identifies strategic cost relationships between logistics performance measures and aggregate problem parameters. Thereby, empirical research methods (such as regression models) are combined with mathematical optimization and simulation models (such as mixed-integer programming or discrete event simulation) to identify best practice relationships. Several topics with applications in transportation, inventory management and procurement are available.
- Supply chain design under uncertainty often involves combinatorial optimization problems. The combination of scenario-based modelling and the combinatorial nature of the problem suggest the application of modern heuristic optimization concepts. Several topics on different applications and search methods are available.

Intended Learning Outcomes:
The objective of the module is to equip the participants with the necessary skill and tools for a successful master thesis project.

Specifically, the aim is to be able to:

- Read and understand recent research contributions
- Pursue interesting research questions
- Conduct a literature study and/or numerical study and/or implementation
- Structure and organize research methods and results
- Write a seminar paper
- Present research findings and defend them in a discussion

Teaching and Learning Methods:
In an introductory session, the current theme of the module is explained by the lecturer and the various available seminar topics are elaborated in detail. Also information on relevant literature for the problem settings is introduced, wich forms the basis of the students' seminar papers. After the introductory session, students will work out the topic on their own, by using their abbilities of conducting literature research, mathematical modelling, programming and analyses. Throughout the whole time, they receive guidance from a supervisor of the chair. Different milestones are to be achieved at specific dates, such as a preliminary outline of the seminar paper, first research results and the final paper. Following the submission of the final paper, presentations and discussions of all students' seminar papers are conducted, usually spanning one or several days, where amongst others also presentation, moderation and discussion skills are trained.

Media:
Presentation, Various forms of literature (Journal Articles, Books, Report, Conference Proceedings, etc.)

Reading List:
'Dependent on seminar focus, e.g.:
'- Kleijnen, J.P.C. (2008), Design and Analysis of Simulation Experiments, Springer
- Bianchi, L. Dorigo, M., Gambardella, L.M., Gutjahr, W. (2009), A survey on stochastic combinatorial optimization, NatComput 8:239-287
- Gutjahr, W. (2011), Recent trends in stochastic combinatorial optimization, Central European Journal of Computer Science 1(1): 58-66.

Responsible for Module:
Minner, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Operations & Supply Chain Management (WIB22964, englisch): Logistics and Supply Chain Management (Limited places) (Seminar, 4 SWS)
Liu C, Minner S
For further information in this module, please click campus.tum.de or here.

Module Description

WIB34001: Advanced Seminar Operations & Supply Chain Management: Operations Research | Advanced Seminar Operations & Supply Chain Management: Operations Research

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Each student is required to submit a term paper (50%) on a specific topic within the focus of the seminar. Moreover, students need to give a presentation (50%) of their work, and they are expected to actively participate in class discussions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students are expected to have a sincere interest in understanding and using complex quantitaive models and methods. Participants should be faimiliar with Operations Research techniques. It is strongly advised that interested students have previously taken part in the module "Modeling and Optimization in Operations Management." Knowledge of the topics convered in the module "Discrete Optimization" is helpful.

Content:
Strategic behaviour is commonplace in all kinds of competitive (and collaborative) settings, ranging from far-reaching political and economical decisions through evolutionary behaviour all the way down to two children sharing a piece of cake. Within the context of operations research, prominent examples of such problems are, e.g., establishing strategy-proof mechanisms of price setting for selling goods in auctions and more general markets and resource allocation problems of scarce resources under different notions of fairness. In this seminar, we are going to discuss a variety of game theoretic problems from a computational perspective. Based on scientific literature, we will discover different types of game theoretic models and their respective solution concepts, as well as methods to find those solutions computationally.

Intended Learning Outcomes:
Upon successful completion of this module students will be able to:
(a) read, understand, and critique scientific papers, (b) deal with advanced material and original literature from the forefront of current research, (c) partake in scientifc discussions, (d) give scientific presentations, (e) understand the basics of scientifc writing, and (f) apply modern quantitative methods and models in related situations.

Teaching and Learning Methods:
Students will be assigned state-of-the-art research papers from the recent literature. They are expected to prepare high-qualtiy presentations and write-ups, reflecting their analyses, understanding and insights from reading the papers and related literature. The lecturer will provide guidance and advice all along, from the choice of the initial topic, to tips on reading original literature, on scientific writing, and on giving successful presentations.

Media:
Slides.Original articles from the scientific literature.

Reading List:
Recent state-of-the-art research papers related to the seminar topic - to be announced at the start of the semester.

Responsible for Module:
Schulz, Andreas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Operations & Supply Chain Management (WIB34001, englisch): Operations Research (limited places) (Seminar, 4 SWS)
Schulz A [L], Schulz A
For further information in this module, please click campus.tum.de or here.

Module Description

WIB39001: Advanced Seminar Operations & Supply Chain Management: Recent Topics in Operations Research and Data Science | Advanced Seminar Operations & Supply Chain Management: Recent Topics in Operations Research and Data Science

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grading consists of i) a presentation (30%) and ii) a seminar paper (70%) and allows to value the two main learning objectives of this seminar i) presenting and discussing recent and own research and ii) conducting and documenting research in a written form.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have a serious interest in production planning systems. Profound knowledge of basic Operations Research techniques are imperative. At minimum students should have attended the module 'Modeling and Optimization in Operations Management'. Additional modeling and programming skills are helpful

Content:
This seminar bases on various methods: First, the lecturer gives an introduction into the general topic and an overview on recent trends and challenges in an introductory session. Herein, different available seminar topics are presented in detail. Then, students will work in small groups on one of the specific topics on their own using and practicing their skills in literature research, mathematical modeling, and programming. During this phase, the students receive weekly guidance and feedback from the lecturer. Furthermore, this work phase is structured through specific milestones, e.g., discussing a preliminary outline, first results, and main findings. Finally, the students create a final paper on their work and presentations as well as discussions of all papers take place such that the students reflect their work and train their presentation skills.

Intended Learning Outcomes:
The objective of this seminar is to provide the students with the necessary skills to conduct independent research, e.g., in preparation for a successful master thesis or a research stay abroad. Herein, students learn how to i) structure a research question and conduct a literature review, ii) use and develop adequate mathematical models, software, and algorithms to solve the research question, iii) write a research paper, especially how to structure and organize results and the corresponding methodology, and iv) work in an academic environment where knowledge is mostly gained from recent papers and less from standardized books

Teaching and Learning Methods:
Production planning is a key element at the core of successful manufacturing systems. In many supply chains, the complexity of and requirements on production systems have increased, e.g., due to a further increasing number of product variants (in the automotive industry) or fluctuating raw material prices (in metal production). Consequently, companies search for new concepts that allow to increase their flexibility to react to current and upcoming challenges while preserving the current efficiency. This seminar focuses on recent enhancements and concepts in today's and future production systems. These topics include, e.g., flexible assembly line layouts, robust production scheduling, production line reconfiguration, and value-based production planning.

Media:
Presentations, varying forms of literature, inverted classroom

Reading List:
selected research papers on production planning and manufacturing systems - to be announced at the start of the semester;
Vollmann, T., Berry, W., Whybark, D., Jacobs, R. (2005): Manufacturing Planning and Control for Supply Chain Management

Responsible for Module:
Schiffer, Maximilian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Operations & Supply Chain Management (WIB39001, englisch): Sustainable Transportation Systems (Limited places) (Seminar, 4 SWS)
Schiffer M, Ulusoy Dereli B, Liepold-Viehweger C
For further information in this module, please click campus.tum.de or here.

Module Description

WIV05001: Advanced Seminar Economics, Policy & Econometrics: Economics of Innovation | Advanced Seminar Economics, Policy & Econometrics: Economics of Innovation [ASEoI]

Economics of Innovation

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students will work in small groups on one of five topics: Creation of knowledge, diffusion of knowledge, industry and macroeconomic aspects, intellectual property rights, innovation policy. The group work aims at 1) understanding the topic in depth and 2) presenting the most important insights from their topic to classmates. Moreover, the students will derive research gaps in the literature related to their topic and summarize both main insights and research gaps in a presentation (20-30 min. per person) to the class. By presenting in a team, students demonstrate their ability within a team to manage resources, and deadlines through timely submission of the enumerated tasks. Finally, they will submit an extended version of the presentation topic as a written research paper (8.000 to 10.000 words). By writing the research paper, students show their ability to work independently on solving complex scholarly problems related to the Economics of Innovation.
The final grade will be based on the written research paper with a weight of 80% and the presentation with a weight of 20%

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Familiarity with microeconomics

Content:
This module will provide students in-depth insights into the field of the Economics of Innovation. The module will discuss some of the prevailing models in the field of Industrial Organization dedicated to the analysis of the incentives and constraints to innovative activities (R&D activities)

as well their relation with imitation, spillovers, firm size and market structure. The module also comprises a dynamic and knowledge-based view, introducing models involving the direct generation of new knowledge, the catching-up/falling behind dynamics of competition and the role played by market selection between innovative firms. The objective of is also to apply the acquired knowledge to selected topics in the field of innovation research. The students will be asked to write a research paper and to present their work in class.

Intended Learning Outcomes:
This module introduces the students to the main issues in the economics of innovation and advances their understanding of the core concepts and principles in the field. The ultimate objective to enhance both theoretical as well as an applied view on the topic enabling students to understand academic as well as public debate on questions related to the economics behind innovation and technological progress. Upon successful completion of this module, students will be therefore able (1) to identify and (2) conceptualize different important issues related to the Economics of Innovation. They (3) are able to identify gaps in the understanding of the focal topic and (4) developed suggestions for improving the understanding of the field. In addition, by presenting their topic to the class, they will (5) enhance their presentation skills and by writing the research paper (6) their scientific writing skills. Through working in groups, the (6) students will work on their teamwork skills.

Teaching and Learning Methods:
The module is a seminar, in which the students will gain in-depth insights in the Economics of Innovation. The seminar will start with an introductory lecture, which will provide the bases for deeper study of the most relevant topics. The first phase will then concentrate on problem-based learning by reading relevant scientific literature and by discussing these articles in the group. In the second phase, students will individually elaborate a written paper as well as presentations in which they need to show their understanding of their focal topic as well as show their capability to identify research gaps in the discussed literature.

Media:

Reading List:
in general:
- Fagerberg, J., Mowery, D. and Nelson, R. R. (2010), Oxford Handbook of Innovation, Oxford: Oxford University Press
- Hall, B. H. and Rosenberg, N. (2010), Handbook of the Economics of Innovation, Oxford: Elsevier,
specific topics:
- Czarnitzki, D., Hottenrott, H. and Thorwarth, S. (2011) ‘Industrial research versus development investment - the implications of financial constraints', Cambridge Journal of Economics, 35, 527-544.

- Jaffe, A., Trajtenberg, M. and Henderson, R. (1993), ‘Geographic Localization of

Knowledge Spillovers as Evidenced by Patent Citations', Quarterly Journal of Economics, 108, 577-598.
- Aghion, P., Dechezleprêtre, A., Hemous, D., Martin, R. and Van Reenen, J. (2016), 'Carbon Taxes, Path Dependency and Directed Technical Change: Evidence from the Auto Industry', Journal of Political Economy, 124 (1).
- Gallini, N. und Scotchmer, S. (2002), 'Intellectual Property: When Is It the Best Incentive System?', in: Jaffe et al. (Eds.), Innovation Policy and the Economy, MIT Press, 51-77.
- Lundval & Borrás (2005), 'Science, technology, and innovation policy', in: Fagerberg, J., Mowery, D. and Nelson, R. R. (eds.), Oxford Handbook of Innovation, Oxford: Oxford University Press, 599-631.

Responsible for Module:
Hottenrott, Hanna; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Economics, Policy & Econometrics (WIV05001, englisch): Economics of Innovation (Limited places) (Seminar, 4 SWS)
Hottenrott H, Rose M
For further information in this module, please click campus.tum.de or here.

Module Description

WI000819: Applied Discrete Optimization | Applied Discrete Optimization [DO]

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exercises (Any combination of homework assignments, semester project or report, and presentation) and
Test (written)

The final grade is composed of individual or group exercises, as well as a written individual test at the end of the semester. The exercises will count for 40%-60% and the test for 60%-40% respectively, of the final grade.

In the exercises, the students show their theoretical understanding and, thus, ability to apply different methodologies, either exact or heuristic, to solve problems including the real-world applications in the field of operations research. In the test, the theoretical understanding of each student is queried.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

This module is dedicated to advanced students who have background in Management Science or Operations Research, specifically in linear programming and duality theory. To work on the assignments, students should have knowledge in using any optimization packages such as OPL/CPLEX, GUROBI, LINGO, or Excel Solver. Knowledge in programming languages is not expected but can be useful for the assignments.

Content:
Discrete optimization problems arise in many practical applications and functional areas. The module Applied Discrete Optimization focuses on the underlying polyhedral theory and both exact and heuristic solution methods to solve
large - scale and complex mathematical models. Topics include
1. Review of linear programming
2. Revised simplex and column generation methods
3. Discrete optimization problems and model formulations
4. Computational complexity
5. Basic exact solution methods:
a. Branch-and-Bound methods
b. Cutting-Plane methods
6. Advanced exact solution methods:
a. Strong Valid Inequalities
b. Branch-and-Cut
c. Dantzig-Wolfe Decomposition
d. Branch-and-Price / Branch-Price-Cut
e. Lagrangian Relaxation
f. Bender’s Decomposition
7. Heuristic / Metaheuristic methods

Intended Learning Outcomes:
At the end of the module, students shall understand the complexity of discrete optimization models, the polyhedral theory, and the theoretical concepts underlying the advanced methods in solving the discrete models. These methods include Branch-and-Cut, Branch-and-Price, Branch-Price-Cut, Benders' Decomposition, and Lagrangian relaxation. Students will be able to apply appropriately these solution approaches to solve their complex problems either by exact or heuristic methods.

Teaching and Learning Methods:
The module consists of a series of lectures that describe the fundamental theories behind the solution methods and illustrate their examples and applications. A few selected technical papers addressing specific problems and solutions to the described problems will be discussed. Assignments are of student groupwork to practice the solution methods learned in class and to review the real-world applications.

Media:

Reading List:

1. Nemhauser G.L. and L.A. Wolsey. Integer and Combinatorial Optimization. Wiley. 1988.
2. Wolsey, L.A. Integer Programming. Wiley. 1998.
3. Wintston, Operations Research: Applications and Algorithms. 1993.
4. Any reference or textbook in management science or operations research.

Responsible for Module:
Schulz, Andreas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Applied Discrete Optimization (WI000819, englisch) (Vorlesung mit integrierten Übungen, 4 SWS)
Schulz A
For further information in this module, please click campus.tum.de or here.

Module Description

WI000836: Advanced Planning in Supply Chains - Illustrating the concepts and methdology using SAP IBP | Advanced Planning in Supply Chains - Illustrating the concepts and methdology using SAP IBP

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module assessment consists of written exam (90 minutes) (50%). By answering the questions in the exam students show that they are able to understand and explain the concepts of hierarchical planning. Furthermore they show that they are able to apply these concepts in supply chain management and to relate them to practical problems. Furthermore students show their ability to develop and apply quantitative approaches with SAP APO for different planning problems. Additionally, two mid-term assignments are held (50%).
The mid-term assignment takes place in the form of two assignments. For each assignment, the students must solve 5 to 10 exercises. These exercises cover various theoretical questions, development of mathematical models, applications of heuristics, as well as implementation in relevant software tools. Hereby, the students demonstrate that they are able to model and solve complex planning problems occurring in supply chain management using standard software. The students hand in their solutions in the form of slides (around 40 to 60 slides per assignment). The assignments are subsequently presented in class, in which each student is asked to present his/her solutions to some of the exercises (approximately 5 minutes per student per assignment). Furthermore, students are expected to participate in the discussion of the solutions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
It is expected that participants have an interest in practical problems of production planning, scheduling and logistics, and the quantitative modelling of business problems. Participants should be familiar with Operations Research (OR) techniques.

The modules "Management Science” and “Production and Logistics” or similar modules at other universities are a prerequisite.

It is strongly advised that the participants have previously taken part in the modules "Basics of Advanced Planning and Supply Chain Management" and "Modelling, Optimization and Simulation in Operations Management" or similar modules at other universities.

Content:
Todays business is characterized by supply networks comprising different partners (e.g. suppliers, distribution and retail centers, plants, customers). Activities within supply networks have to be well coordinated in order to avoid excessive inventories, inefficient capacity utilization and poor customer service.

Over the recent years so-called Advanced Planning and Scheduling (APS) systems have emerged which complement traditional ERP systems. Their major characteristics are the use of mathematical optimization techniques and the integration into comprehensive supply chain management concepts. In this teaching module we will look more closely at SAP's advanced planning tool APO and use a case from the food industry, the fruit juice producer Frutado, to illustrate how integrated planning over various modules and decision levels can be realized.

Content:
1. The Frutado case
2. Hierarchical Planning and the Supply Chain Planning Matrix
3. SAP APO - Module Matrix and General Principles
4. Demand Planning
5. Supply Network Planning
6. Production Planning and Detailed Scheduling
7. Deployment and Transportation Load Builder
8. Transportation Planning and Vehilce Scheduling
8. Global Available-to-Promise

Intended Learning Outcomes:
After the module students will be able to:
• Know the concepts and methodologies used in advanced planning
• Apply the quantitative techniques used advanced planning for supply chain management
• Understand the structure and methodology used in commercial Advanced Planning Systems (APS) such as SAP APO
• Understand the interdependence of planning decisions made on different levels of the planning hierarchy
• Model practical planning problems with SAP APO
• Use and develop an advanced planning methodology for solving real-life problems in demand planning, supply network planning, production planning and detailed scheduling, available-to-promise, deployment and transportation, also involving several levels of the decision hierarchy

Teaching and Learning Methods:
The module consists of a lecture with integrated exercise sessions.
During the lecture part of the contents are delivered through presentations and talks. The students are inspired to improve the acquired knowledge by studying the suggested literature, compiling reports and giving presentations. In the exercise sessions the students apply the acquired knowledge by solving exercises and working on a large scale SAP APO case study.

Media:
Presentations, scriptum, handouts, cases and solutions

Reading List:
Stadtler, H., Fleischmann, B., Grunow, M., Günther, H.-O., Meyr, H., Advanced Planning in Supply Chains Illustrating the Concepts Using an SAP APO Case Study, Berlin et al., Springer, ISBN 978-642-24214-4

Responsible for Module:
Grunow, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WI000976: Logistics and Operations Strategy | Logistics and Operations Strategy

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
At the end of the module a 90-minutes exam will determine the grading of the students. Students choose 3 out of 4 questions. Within each question two different competence areas are assessed. The first part of each questions covers knowledge about strategic operational and logistics concepts from the lecture. Then, in a second part, multiple quantitative methods have to be applied. They involve calculation and the analysis of results like in the exercise classes. Since calculations are to be done, a pocket calculator and a formula sheet summarizing the most relevant formulas and statistical values may be used by the students.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module requires basic knowledge in statistics (discrete and continuous probability distributions), MS Excel and the course “Modelling, Optimization, and Simulation”, which is due to the extensive use of Mixed-Integer Linear Programming. Basic knowledge of micro-economics theory helps, but is not a must.

Content:
The module will position logistics and operations in business strategy and industrial organization. Strategic modelling and optimization approaches and tools for sourcing strategy, facility location, capacity and flexibility management will be presented and applied to problems of different industries.

Topics the module covers include:
- Competitive strategy (monopoly, simultaneous/sequential quantity competition, capacity competition, competitive locations)

- Operations strategy and Industrial Organization (supply chain configuration/operational flexibility)
- Capacity strategy (sizing and investment, timing and expansion)
- Distribution network strategy (warehouse location problem/hub- and spoke systems)
- Process technology (Make-to-order vs. Make-to-stock, factory physics)
- Operations and risk management (hedging/sourcing/inventory strategies)

Intended Learning Outcomes:
The participants will acquire knowledge on different views of logistics strategy from a market and a resource perspective and will be enabled to apply decision support tools for an effective design of global manufacturing and logistics networks. Students will be able to assess strategic problems from practice, categorize them according to the decisions involved and identify relevant solution methods to solve them. Furthermore, students are equipped with the ability to apply methodologies and techniques from theory in practical environments. After finishing the module, students will be able to evaluate innovative and complicated operations and logistics settings, such as the integration of additive manufacturing (3D printing), and create subsequent innovative solution approaches for strategic decision makers.

Teaching and Learning Methods:
The series of lectures provides students with a fundamental knowledge of concepts and methods for assessing and optimizing given problems. Exemplary problem settings are solved during exercise classes, where the content given in the lecture is applied. Optimizations using MS Excel solver and analytical calculations are the basis for a follow-up interpretation of the results. In the process, students present their work and conduct an interactive discussion with fellow students and the lecturer regarding their approach, solution and interpretation. Extending the theoretical exercises, case studies are used to let students analyse and solve real-world problems, which closes the gap between theory and practice. To give students a further glimpse into practice, guest speakers from various industries present their daily challenges and approaches to solve them. This allows students to make the connection between the theoretical concepts they have learned and the requirements in practice and provides the opportunity to discuss questions with practitioners and find problem settings that might be suitable for their final thesis.

Media:
Literature, Slides, Case Studies, Exercises

Reading List:
Van Mieghem, J.A. (2015) Operations Strategy Principles and Practice, 2nd Edition, Dynamic Ideas
Slack, N., Lewis, M. (2015), Operations Strategy, 4th Edition, Financial Times/Prentice Hall.
Belleflamme, P., Peitz, M. (2015), Industrial Organization: Markets and Strategies, 2nd Edition, Cambridge University Press.

Responsible for Module:
Minner, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Logistics and Operations Strategy (WI000976, englisch) (Limited places) (Vorlesung mit integrierten Übungen, 4 SWS)
Minner S [L], Minner S, Wang Y, Zhu K
For further information in this module, please click campus.tum.de or here.

Module Description

WI000977: Stochastic Modeling and Optimization | Stochastic Modeling and Optimization

Version of module description: Gültig ab summerterm 2016

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grading is based on a written exam (90 minutes) consisting of 4 questions, the participants can choose 3 out of 4. Each question has several parts assessing the different competence levels. Students show that they understand a set of advanced stochastic methods. Each question requires the application of a stochastic method, or combinations of several methods. That shows students' ability to compare, choose and, combine different stochastic methods. Students have to conduct 1) practical implementation exercises and 2) theoretical proofs. The exam is open-book, students are allowed to use their own laptops for solving the programming exercises.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module requires a solid knowledge in probability theory and linear optimization. The knowledge of a programming language is helpful and the course “Modelling, Optimization, and Simulation” due to extensive use of Mixed-Integer Programming and Simulation methods.

Content:
The module covers different state-of-the art methods for decision support in stochastic real-world environments. This contains methodology for multi-period problems and takes into account different states of the world. The module covers both, the mathematical theory behind the methods and presents their applications to industry problems such as inventory management or call center staffing.
Specifically, the module covers the topics:
• Uncertainty Modeling: Probability Theory, Stochastic Processes,
• Fuzzy Set Theory,
• Newsvendor Problems, Bayes Updating, Forecast Evolution

• Stochastic Dynamic Programming and Approximate Dynamic Programming
• Markov Chains and Markov Decision Processes: LP, Value Iteration, Policy Iteration
• Stochastic Programming: Chance Constrained Programming,
• Two-Stage Models with Recourse, Sample Average Approximation, Sampling Strategies
• Simulation Optimization Applications: Queuing Theory, Queuing Networks, Factory Physics, Inventory Theory (single echelon, multi-echelon)

Intended Learning Outcomes:
After participating in this module, students are able to understand and interpret a set of advanced stochastic methods. They are able to apply these concepts in practice and transfer the methods to real life. Students further comprehend the weaknesses and strengths of the methods. They are able to assess which method to apply in which context. Students further have the ability to make appropriate use of related software. Through (voluntary) homework and the discussion and presentation of different solutions in class, students further improve their skills of carrying out discussions within a research environment. They gain insights into academic work, as most material will be learned from scientific papers rather than from books. The course will prepare the students for their master thesis.

Teaching and Learning Methods:
In lectures, students learn to understand the mathematical theory and obtain insights in applications of the stochastic methods to a practice context. Students get exercise sheets with problems that go beyond the examples in the lecture and allow them to reproduce and extend their knowledge. For solving the exercises, they are provided with the necessary software, such as Matlab or Xpress. In exercise classes, students discuss their solutions of the homework, and find out about the differences in practicability of one method over the other. In addition, there are guest lectures of practitioners who apply advanced methodology in their daily work and motivate new fields of application of the models beyond the scope of the lectures.

Media:
Literature, Slides, Case studies, Exercises, Software

Reading List:
• Tijms, H.C. (2003), A First Course in Stochastic Models, Wiley
• King, A.J., Wallace, S.W. (2012), Modeling with Stochastic Programming, Springer
• Kleijnen, J.P.C. (2008), Design and Analysis of Simulation Experiments, Springer
• Powell, W. (2011), Approximate Dynamic Programming, 2nd ed., Wiley

Responsible for Module:
Minner, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Stochastic Modeling and Optimization (WI000977, englisch) (Limited places) (Vorlesung mit integrierten Übungen, 4 SWS)
Minner S [L], Minner S, Abbaszadeh Nakhost M

For further information in this module, please click campus.tum.de or here.

Module Description

WI000979: Inventory Management | Inventory Management

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grading is based on a written exam (90 minutes) consisting of 4 questions, the participants can choose 3 out of 4. Each question has several parts assessing the different competence levels. In a first theory part, the student has to reproduce knowledge about inventory management concepts. In a second part, different calculation methods need to be applied with given data and the results be analyzed and interpreted. In a third part, the students need to develop ideas and concepts beyond the reproduction of knowledge and application of methods. In order to facilitate calculations and for backup of some statistical formulas, a formula sheet and a pocket calculator can be used.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module requires basic knowledge in statistics (discrete and continuous probability distributions) and Excel and the course “Modelling, Optimization, and Simulation” due to extensive use of Mixed-Integer Programming and Simulation methods.

Content:
Standard inventory control models and approaches are presented for single- and multi-period dynamic inventory models, multi-echelon models, and multi-product coordinated replenishment problems. Further, different approaches to data driven inventory policies are presented that address the estimation and analysis of model parameters. Case studies and board games are used to motivate these concepts.

Specifically, the module covers the topics:
• Performance metrics;
• Lot sizing: EOQ, EPQ, Wagner Whitin;
• Forecasting: Time series, regression, data analysis, probability distributions;

• Newsvendor model;
• Single echelon inventory control: (R,S), (s,Q)policies and parameter optimization;
• Multi echelon inventory control: Concepts, lot sizing, safety stock optimization, METRIC;
• Multiproduct models: ELSP, CLSP, DLSP, CSLP, PLSP;
• Warehouse scheduling, joint replenishment problems;
• Multi location problems;
• Sport Obermeyer Case and MIT Beer Distribution Game;
• Special topics: Perishable items, multi supplier models, lost sales models

Intended Learning Outcomes:
The participants will learn about different concepts in Inventory management and receive the knowledge to apply decision support tools for an effective design and operation of inventory management systems. They will be able to memorize different inventory control rules, identify the right model in different industry environment and be able to reproduce parameter calculations. They will be able to illustrate the impact of cost and service parameters on timing and sizes of replenishment decisions and generalize these finding to more complex multi-echelon and multi-product systems. This fundamental knowledge will enable participants to evaluate, compare and optimize different control systems, revise parameter settings and critically reflect on optional choices. Upon completion of this module, the participants will be able to develop and implement models and methods for new and innovative inventory management problems, e.g. arising in same-day home delivery, car-sharing or reverse logistics applications.

Teaching and Learning Methods:
The module includes lectures where students obtain knowledge about inventory modeling and optimization techniques. In exercise sessions, the students solve problems with the obtained knowledge, perform optimizations and simulations, interpret the findings and present and discuss their results to the others participants in the classroom. Computer programs are provided to the students who adapt those to determine inventory control parameters and to simulate inventory system performance. Case study and business game sessions give the participants a first hand, interactive experimental experience into the dynamics of inventory systems and real world problems. Guest lectures given by industry professionals supplement the theory parts and give the participants the opportunity to recognize problems, discover interesting challenges for choosing their thesis work and discuss with practitioners.

Media:
Literature, Slides, Case studies, Business games, Exercises, Software

Reading List:
• Silver, E.A., Pyke, D.F., Peterson, R. (1998), Inventory Management and Production Planning and Scheduling, 3rd edition, Wiley.
• Axsäter, S. (2006), Inventory Control, 2nd. Ed., Springer.
• Zipkin, P. (2000), Foundations of Inventory Management, McGraw-Hill.

Responsible for Module:
Minner, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Inventory Management (WI000979, englisch) (Limited places) (Vorlesung mit integrierten Übungen, 4 SWS)
Minner S [L], Helm P, Minner S, Wang Y
For further information in this module, please click campus.tum.de or here.

Module Description

WI001034: Service and Health Care Operations Management | Service and Health Care Operations Management

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Grading of the module will be based on the following four assessments: At the end of the module the students have to take an open book written test of 60 minutes length. Through the module students have to hand in two assignments and have to make a 15-minute presentation followed by a 5-minute discussion. Through the test the students show that they have understood the health care operations model treated in the module. By undertaking the two assignments students demonstrate that they have acquired the capability of i) implementing a health care optimization model by using a modelling language and a solver, and of ii) implementing a health care simulation model by using a discrete event simulation. With the presentation students showcase their understanding and capability of presenting a health care problem and approach from the scientific literature so far not treated in class. The assessments are weighted with 50% (test), 15% (optimization assignment), 15% (simulation assignment) and 20% (presentation).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have knowledge in the mandatory undergraduate courses Mathematics (Linear Algebra), Statistics (probabilities, distributions), Management Science or Operations Research (Linear and Integer Programming), Production and Logistics or Operations Management, Programming, as well as a course in modelling and simulation such as in the elective undergraduate course “Modelling, Optimization and Simulation”.

Content:
• Legal and institutional foundations of health care operations in hospitals
• Case mix planning
• Admission planning

• Patient flow planning
• Appointment scheduling
• Emergency and assessment unit planning
• Master surgery scheduling
• Nurse rostering
• Bed assignment
• Sequencing and scheduling surgeries

Intended Learning Outcomes:
Upon completion of the module students are empowered to analyze and optimize health care processes in hospitals. In particular they 1) know the prevalent health care operations models and methods available in the literature. 2) They know how to model and solve linear programs for optimizing health care processes with off-the-shelf software. 3) They are be capable of assessing a health care system by undertaking a simulation. And 4) they are able to understand and present new approaches for health care operations available in the scientific literature. Beyond knowledge on health care operations management students know and can apply advanced OR-techniques such as goal programming and stochastic programming. Also students are capable of applying elementary operations management approaches such as scheduling, sequencing and shift scheduling relevant for operations management in general and service operations management in particular.

Teaching and Learning Methods:
Each topic will be treated based on one or two papers in scientific journals. Students are advised to prepare for the lecture by reading these papers ahead of class. In the class the health care operations problem addressed and the solution approach proposed will be presented by the lecturer and discussed with the students. For the exercise the students have to prepare applications of the approaches by solving small cases which will be discussed afterwards.
The lecture and the case based exercises will be helping students to understand the problems addressed and the solution approaches provided. In order to empower students to implement the approaches in practice students will undertake two assignments. In the first assignment students implement an optimization model with the modelling language OPL and the solver CPLEX. In the second assignments students undertake a simulation of a health care system with the software AnyLogic. The two assignments will be provided at the beginning of the module giving students some time in order to undertake them. During the time of working at the assignments students can consult the teaching assistant in the exercise for help. In order to empower students to address health care problems not treated in class, students have to select and present a problem and an associated solution approach from the literature in class.

Media:
Slides, scientific paper

Reading List:
Vissers, J. and Beech, R. (2005): Health Operations Management, Routledge, London and New York.

Responsible for Module:
Kolisch, Rainer; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Service and Health Care Operations Management (WI001034, englisch) (Limited places) (Vorlesung mit integrierten Übungen, 4 SWS)
Kolisch R, Bentzen L
For further information in this module, please click campus.tum.de or here.

Module Description

WI001088: Advanced Modeling, Optimization, and Simulation in Operations Management | Advanced Modeling, Optimization, and Simulation in Operations Management [AMOS]

Version of module description: Gültig ab summerterm 2016

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The offered module is composed of the sections optimization and simulation. In both sections, basic knowledge and skills for designing and evaluating service and production processes are taught. The solution of analyzed problems is gained either through the application of optimization methods or through simulation. Due to the different problem-solving approaches (and the use of different software packages), both sections are thought separately. To facilitate the learning success, the learning outcomes are examined directly at the end of each section. At the end of the optimization section, there is a written exam on modeling linear optimization problems. In addition to theoretical knowledge, the students' skills in modeling with OPL and IBM ILOG CPLEX are tested. At the end of the simulation section, there is also a written exam, in which the learning outcomes in discrete-event simulation, using the software AnyLogic are tested. Both exams evaluate the individual performance of the acquired theoretical and practical skills, requiring own calculations and argumentative answers. Exams are worth 60 points each and noncumulative. To pass the course, students need to pass both exams individually. The final grade of the module is the truncated average of the exam grades. Both exams take 60 minutes each. In the exams, no aids are allowed. In addition, students can achieve a 0.3/0.4-grade bonus (according to APSO/FPSO midterm) in each section through the successful participation in the respective homework assignments.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Management Science, Basic course in Statistics, Basic Couse in Mathematics, Production and Logistics

Content:
The acquired skills are used in the field of operations management to understand, redesign, control and optimize the production of goods and services. The students learn quantitative methods for the analysis of decision problems in operations management, and therefore, the basis for all subsequent lectures at the Department of Operations & Supply Chain Management. The presented methods can be subdivided into two distinct study sections: optimization and simulation.
Optimization section:
- Introduction to linear programming, CPLEX Studio IDE, and IBM ILOG OPL
- LP formulations, e.g. production planning problems
- Model building with OPL, e.g. generic modeling, model testing with instances, scripting for pre- and post-processing
- Interpreting and using the solution of a LP model
- Spreadsheet input/output with OPL

Simulation section:
- Introduction to simulation, AnyLogic
- System; event; model; steps in a simulation study
- Data collection, statistical analyse and input modeling
- Fundamental simulation concepts in AnyLogic
- Simulation of simple systems together with verification, calibration, and validation
- Statistical simulation data output analysis having regard to different scenarios

Intended Learning Outcomes:
At the end of the module, students will be able to create mixed integer linear programming formulations, and discrete event simulation models of simple problems in production and operations management.
Furthermore, students will be able to solve MILP formulations in OPL and IBM ILOG Script, and implement discrete event simulation models in AnyLogic. The students also learn, how to evaluate and compare the calculated problem solutions.

Teaching and Learning Methods:
The weekly sessions consist of a lecture with an integrated exercise class. During the lecture, the content is presented and discussed. The students are invited to improve the acquired knowledge by studying the suggested literature. In the exercise, the students apply the acquired knowledge by solving and implementing given problems. The homework assignments allow students to individually improve their skills, by answering theoretical questions and implementing problems, using the respective software. After each homework assignment, the students are free to discuss their solutions and open questions in a Q&A session.

Media:
PowerPoint, Exercise sheets, Whiteboard

Reading List:
Optimization
- Williams, H. P. (1999): Model Building in Mathematical Programming. 4th edition.

Supplementary reading materials about optimization and linear programming
- Domschke, W. and Drexl, A. (2005): Einführung in Operations Research. 6th edition, Springer.
- Domschke, W., Scholl, A. and Voss, S. (1997): Produktionsplanung. 2nd edition, Springer.
- Hillier, F. S. and Lieberman, G. J. (2004): Introduction to Operations Research. 8th edition, McGraw-Hill.
- Klein, R. and Scholl, A. (2004): Planung und Entscheidung. Vahlen.
- Winston, W. L. (2004): Operations Research. 5th edition, Thomson.

Simulation:
- Kelton, W. D., Sadowski, R. P. and Sturrock, D. T. (2010): Simulation with ARENA. 5th edition, Boston: McGraw-Hill.

Supplementary reading materials about simulation and statistics
- Banks J., Carson J. S., Nelson, B. L. and Nicol. D. M. (2009): Discrete-Event System Simulation. 5th edition, Upper-Saddle-River: Prentice Hall.
- Law, A.M. (2007): Simulation modeling and analysis. 4th edition, McGraw-Hill, New York
- Bleymüller, J., Gehlert, G., Gülicher, H. (2008): Statistik für Wirtschaftswissenschaftler. 15th edition, München: Verlag Vahlen.

Responsible for Module:
Kolisch, Rainer; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Simulation in Operations Management (WI001088, englisch) (Limited places) (Seminar, 2 SWS)
Jost C, Pahr A

Advanced Modeling and Optimization in Operations Management (WI001088, englisch) (Limited places) (Seminar, 2 SWS)
Jost C, Pahr A
For further information in this module, please click campus.tum.de or here.

Module Description

WI001135: Stochastic Optimization | Stochastische Optimierung

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Grading is based on of a final exam (60%), written presentation of the results obtained for the homework (40%), and bonus points are awarded for participation in discussions in the lecture and the lab. With this voluntary mid-term assignment students can improve their module grade. The homework during the semester serves to assess the ability to apply stochastic optimization to real world problems. By this method, the students continually reflect about the theory presented in class and learn to translate theoretical knowledge into practical solutions. The in-depth knowledge of the theory of stochastic optimization and the critical reflection of its limitations are assessed in a final written exam focussing on the theoretical knowledge. Moreover, the students can prove their ability to relate these theoretical results to real world problems. The presentation and discussion of the homework in the lab sessions measure students' ability to structure and present their results, connect them with state-of-the-art methods and theories, and present them in a scientific way.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of basic linear optimization and basic probability theory would be an advantage. The required theory is reviewed in the class.

Content:
In this module students learn about the theory and the methods of stochastic optimization. The theory is complemented by a range of real-world examples with a focus on applications in energy trading and finance. Along with the examples an introduction to software tools is given that enables students to solve stochastic optimization problems. The required mathematical tools will be introduced along the way.

The module contents span the theory of stochastic optimization (two-stage and multi-stage), numerical solution methods, the treatment of risk via risk measures in stochastic optimization, as well as sampling based approaches.
In particular, topics of the course include but are not limited to
- What is stochastic optimization
- Two-stage linear stochastic optimization with recourse
- Computational methods
- Monte-Carlo methods
- Multi-stage models
- Risk measures in stochastic optimization

Intended Learning Outcomes:
After the successful completion of this module, students are able (1) to understand the basic theory of stochastic optimization, (2) to critically reflect the limitations of the theory, (3) to implement solution approaches for stochastic optimization using MATLAB in combination with numerical solvers, (4) to model real-world problems under uncertainty as stochastic optimization problems that can be treated with the methods introduced in the course, (5) to communicate the results to a scientific audience.

Teaching and Learning Methods:
The module combines several learning methods.
To facilitate a better understanding of the subject the course is divided into lectures and a lab (excercise). In the lectures theory is presented which is subsequently applied by students in homework assignments using MATLAB. The solutions are handed in and students can volunteer to present their solutions in the lab. In private reading, students complement the knowledge from the lecture with additional methods relevant for solving the cases. Students reflect on the theory and their applicability in class and during class discussion. By working on real world stochastic optimization problems, handling actual data, and designing numerical solution approaches as well as engaging in discussions of their homework solutions, participants get in-depth knowledge about the basics of stochastic optimization.

Media:
Lecture notes, presentations, scientific literature

Reading List:
Birge, J. and Louveaux, F. Introduction to Stochastic Programming. Springer Series in Operations Research and Financial Engineering, 2011 (second edition).
Shapiro, A. and Dentcheva, D. and Ruszczynski, A. Lectures on Stochastic Programming: Modeling and Theory. MOS-SIAM Series on Optimization. 2014 (second edition).

Responsible for Module:
Wozabal, David; Prof. Dr. rer. soc.

Courses (Type of course, Weekly hours per semester), Instructor:
Stochastic Optimization, Lecture, 2 SWS
Stochastic Optimization, Excercise, 2 SWS
Prof. Dr. David Wozabal
For further information in this module, please click campus.tum.de or here.

Module Description

WI001189: Computational Logistics | Computational Logistics

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Grading of the course will be through homework assignments (25%) and an individual final term project assignment (75%). Students work in groups on the project work. Students demonstrate their ability within a team to manage resources, and deadlines through timely submission of the tasks. Students demonstrate that they are able to complete the tasks of their project in a team environment. In the project report students demonstrate that they can develope, describe and evaluate heuristics and metaheuristics. Accompanied with the report, models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. With the analyses students show that they can implement the methods. At the end of the module students present their work in final presentation and participate in the discussion of the projects of their fellow participants.
Every student will be graded individually based on the report, the final presentation and the discussion.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module requires a solid knowledge in linear optimization. Basic knowledge of a programming language and the course “Modelling, Optimization, and Simulation” are required.

Content:
The module covers different heuristics and metaheuristics for decision support in linear optimization. This contains methodology for solving logistics problems using algorithms.
The module covers both, the theory behind the methods and the implementation of the algorithms in a computer language.
Specifically, the module covers the topics:
• Construction heuristics,

• Metaheuristics,
• Matheuristics
• Parameter Tuning

Intended Learning Outcomes:
After participating in this module, students are able to understand the different concepts of heuristics and metaheuristics. They are able to implement these methods in a computer and analyze the results.
Students further comprehend the weaknesses and strengths of the methods. They are able to apply the method to a practical problem in the area of logistics in the context of a project. Through the project report and the presentations, students further improve their skills of writing academic reports and carrying out discussions within a research environment. Students are able to integrate involved persons into the various tasks considering the group situation. Furthermore the students conduct solution processes through their constructive and conceptual acting in a team. The course will prepare the students for their master thesis.

Teaching and Learning Methods:
In lectures, students learn to understand the theory of heuristics, metaheuristics, and matheuristics. In the integrated exercise sessions, students learn the use and the implementation of these algorithms. For solving the exercises, they are provided with the necessary software, such as Java or Xpress. In addition, student groups will work on a group project throughout the semester, which they will present in a final presentation and a report.

Media:
Literature, Slides, Exercises, Software, Project case

Reading List:
• Deroussi, L. (2016), Metaheuristics for Logistics, Wiley
• Labadie, N., Prins, C., & Prodhon, C. (2016). Metaheuristics for Vehicle Routing Problems, Wiley

Responsible for Module:
Minner, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Computational Logistics (WI001189, englisch) (Limited places) (Vorlesung mit integrierten Übungen, 4 SWS)
Minner S [L], Abbaszadeh Nakhost M, Kuttruff N, Minner S
For further information in this module, please click campus.tum.de or here.

Module Description

WI001193: Transportation Analytics | Transportation Analytics

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grading is based on assignments which consist of an implementation and a written report (15 pages). Students work in groups on the assignments. Students demonstrate their ability within a team to manage resources, and deadlines through timely submission of the tasks. Students demonstrate that they are able to complete the tasks of their assignment in a team environment. In the written report students demonstrate that they can understand, model, implement, and evaluate logistics problems. Accompanied with the report, models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. With the analyses students show that they can implement the methods. Every student will be graded individually based on the written report and the implementation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module requires a solid knowledge in linear optimization. The course “Modelling, Optimization, and Simulation” is required.

Content:
The module covers different transportation problems for decision support in linear optimization.
This contains methodology for solving logistics problems using algorithms.
The module covers both, the theory and the implementation of the solution methods in a computer language.
Specifically, the module covers the topics:
• Traveling Salesman Problem,
• Vehicle Routing Problem,
• Network Design Problem
• Maritime Logistics

Intended Learning Outcomes:
Students will be able to model transportation, routing and network design problems as mixed-integer linear program Further, they will be able to implement and to solve these problems to provide practical decision support and to understand the concepts and methods behind commercial decision support software. They can contribute an own part to a team's work output. They recognize potential conflicts in working together as a team and they reflect upon these considering varying conditions.

Teaching and Learning Methods:
In lectures, students learn to understand the theory of transportation problems. In the integrated exercise sessions, students learn the use and the implementation of these problems. For solving the exercises, they are provided with the necessary software, such as Java or Xpress. In addition, student groups will work on assignments throughout, they will submit as a report and the implementation itself.

Media:
Literature, Slides, Exercises, Software

Reading List:
•Toth, P., & Vigo, D. (Eds.). (2014). Vehicle routing: problems, methods, and applications (Vol. 18). Siam
• Williams, H. P. (2013): Model Building in Mathematical Programming. 5th edition.
• Hillier, F. S. and Lieberman, G. J. (2015): Introduction to Operations Research. 10th edition, McGraw-Hill.

Responsible for Module:
Minner, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Transportation Analytics (WI001193, englisch) (Limited places) (Vorlesung mit integrierten Übungen, 4 SWS)
Minner S [L], Kuttruff N, Minner S
For further information in this module, please click campus.tum.de or here.

Module Description

WI001206: Modeling Future Mobility Systems | Modeling Future Mobility Systems

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grading consists of a presentation (5-8 minutes per student, 50%) and a complementary written précis (5-10 pages per student, 50%) and allows to value the two main learning objectives of this module: i) presenting and discussing recent and own research and ii) conducting and documenting research in a written form. In the presentation, students demonstrate that they are able to structure a research question, to organize the results, and to present in a clear and comprehensible manner to an audience. Furthermore, they demonstrate that they are able to respond adequately to questions. By documenting their research students show their ability to develop adequate mathematical models, software, and algorithms to solve the research question. The presentation and the précis are held and written by groups of at maximum 4 students. For both the students' contribution is clearly identifiable and will be assessed individually.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have a serious interest in future mobility systems. Profound knowledge of basic Operations Research techniques are imperative. At minimum students should have attended the module 'Modeling and Optimization in Operations Management'. additional modeling and programming skills are helpful.

Content:
Transportation systems are seen as some of the most pervasive and influential systems in any society or economy as they are key enabler for central achievements, e.g., individual mobility, trade, globalization, and wealth. Hence, transportation systems have a huge socio-economic impact but also face tremendous challenges as transportation must (in a best case scenario) meet the triple bottom line, fulfilling economic, ecological, and social requirements. To achieve this goal,

today’s and future transportation systems for both freight and passenger transportation become more and more complex, especially in the context of intermodal freight transportation, autonomous driving, shared mobility, and the physical internet. Huge challenges but also achievable benefits for both society and investors remain in the next decade.
This module covers recent enhancements and concepts in today's and future mobility systems, always on the cutting edge of research. These topics include, e.g., autonomous mobility on demand systems, electric vehicles, intermodal and multimodal transportation.

Intended Learning Outcomes:
The objective of this module is to provide the students with the necessary skills to conduct independent research, e.g., in preparation for a successful master thesis or a research stay abroad. Herein, students are able to i) structure a research question and conduct a literature review, ii) use and develop adequate mathematical models, software, and algorithms to solve the research question, iii) present their research question in a clear and comprehensible manner to an audience, iv) structure and organize results and the corresponding methodology, v) work in an academic environment where knowledge is mostly gained from recent papers and less from standardized books.

Teaching and Learning Methods:
This module bases on various methods: First, the lecturer gives an introduction into the general topic and an overview on recent trends and challenges in an introductory session. Herein, different available topics are presented in detail. Then, students will work in small groups on one of the specific topics on their own using and practicing their skills in literature research, mathematical modeling, and programming. During this phase, the students receive weekly guidance and feedback from the lecturer. On demand, the lecturer details topics of special interest in additional lectures. Furthermore, this work phase is structured through specific milestones, e.g., discussing a preliminary outline, first results, and main findings.

Media:
Presentations, varying forms of literature, inverted classroom

Reading List:
Gentile, G., & Noekel, K. (2016). Modelling public transport passenger flows in the era of intelligent transport systems. Gewerbestrasse: Springer International Publishing.
Additional selected research papers on recent developments in future mobility systems will be announced at the start of the semester

Responsible for Module:
Schiffer, Maximilian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Modeling Future Mobility Systems (WI001206, englisch) (Limited places) (Seminar, 4 SWS)
Schiffer M, Ulusoy Dereli B
For further information in this module, please click campus.tum.de or here.

Module Description

WI700007: Modules from DTU 1:1 program | Module im Rahmen des DTU 1:1 Programmes

Version of module description: Gültig ab summerterm 2019

Module Level: Master	Language: English	Duration: one semester	Frequency: winter/summer semester
Credits:* 6	Total Hours:	Self-study Hours:	Contact Hours:

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Within this module certain courses of the 1:1 program with the Denmarks Tekniske Universitet (DTU) can be recognized. If you are interested in the program, you can find more information here: https://www.wi.tum.de/student-life/joint-international-programs/.

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.