CONSTRUCTOR UNIVERSITY

Study Program Handbook

Industrial Engineering and Management

Bachelor of Science

Subject-specific Examination Regulations for Industrial Engineering & Management (Fachspezifische Prüfungsordnung)

The subject-specific examination regulations for Industrial Engineering & Management are defined by this program handbook and are valid only in combination with the General Examination Regulations for Undergraduate degree programs (General Examination Regulations = Rahmenprüfungsordnung). This handbook also contains the program-specific Study and Examination Plan (Chapter 6).

Upon graduation, students in this program will receive a Bachelor of Science (BSc) degree with a scope of 180 ECTS (for specifics see Chapter 4 of this handbook).

Current version	**Valid as of**	**Decision**	**Details**
Fall 2023 – V2.1		Sep 18,2023	Editorial changes in the study and scheme plan
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1 Program Overview

1.1 Concept

1.1.1 The Constructor University Educational Concept

Constructor University aims to educate students for both an academic and a professional career by emphasizing three core objectives: academic excellence, personal development, and employability to succeed in the working world. Constructor University offers an excellent research driven education experience across disciplines to prepare students for graduate education as well as career success by combining disciplinary depth and interdisciplinary breadth with supplemental skills education and extra-curricular elements. Through a multi-disciplinary, holistic approach and exposure to cutting-edge technologies and challenges, Constructor University develops and enables the academic excellence, intellectual competences, societal engagement, professional and scientific skills of tomorrows leaders for a sustainable and peaceful future.

In this context, it is Constructor University's aim to educate talented young people from all over the world, regardless of nationality, religion, and material circumstances, to become citizens of the world who are able to take responsible roles for the democratic, peaceful, and sustainable development of the societies in which they live. This is achieved through a high-quality teaching as well as manageable study loads and supportive study conditions. Study programs and related study abroad programs convey academic knowledge as well as the ability to interact positively with other individuals and groups in culturally diverse environments. The ability to succeed in the working world is a core objective for all study programs at Constructor University, both in terms of actual disciplinary subject matter and also to the social skills and intercultural competence. Study-program-specific modules and additional specializations provide the necessary depth, interdisciplinary offerings and the minor option provide breadth while the university-wide general foundation and methods modules, optional German language and Humanities modules, and an extended internship period strengthen the employability of students. The concept of living and learning together on an international campus with many cultural and social activities supplements students' education. In addition, Constructor University offers professional advising and counseling.

Constructor University's educational concept is highly regarded both nationally and internationally. While the university has consistently achieved top marks over the last decade in Germany's most comprehensive and detailed university ranking by the Center for Higher Education (CHE), it has also been listed by the renowned Times Higher Education (THE) magazine as one of the top 300 universities worldwide (ranking group 251-300) in 2019 as well as in 2021. Since 2022 Constructor University is considered to be among the top 30 percent out of more than 1600 universities worldwide and is ranked the most international university in Germany. The THE ranking is considered as one of the most widely observed university rankings. It is based on five major indicators: research, teaching, research impact, international orientation, and the volume of research income from industry.

1.1.2 Program Concept

Industrial engineering is one of the most versatile and flexible branches of engineering. It has been said that engineers make things, whereas industrial engineers make things better. Industrial Engineering deals with both the creation and the management of systems that integrate people, materials and energy in productive ways.

The BSc Industrial Engineering & Management (IEM) covers topics such as process engineering, operations research, supply chain management, engineering design, logistics, and project management. During their studies at Constructor University, students are equipped with the essentials of business functions from both an engineering and management perspective and are thus prepared for successful careers in the industry. They learn to optimize processes and resources as well as to manage international firms and projects.

In an ever-changing and developing world, industrial engineering is essential for modern societies as it helps to design sustainable systems. IEM students at Constructor University learn how to adapt to the new digital technologies and trends that businesses are adopting as well as the global challenges society is facing.

The IEM program is of special interest to those who:

- are interested in how production and distribution processes are organized across different industries and multinational companies;
- want to design efficient systems, optimize processes and manage resources and people;
- aim to work at the border of engineering and management, with a focus on supply chain management, logistics, project management, or consulting.

The Industrial Engineering & Management BSc program has received excellent results in the most recent university ranking conducted by the Center for Higher Education (CHE, see https://ranking.zeit.de/che/de/fachbereich/603233).The CHE ranking is based on a comparison of more than 300 universities and other higher education institutions. The main indicators are teaching quality, research, and study environment. In most of these criteria Industrial Engineering & Management at Constructor University has been placed in the top group.

Moreover, previous IEM students have been awarded for the research conducted as part of their thesis projects. They have received thesis awards such as the Scientific Prize of the OLB Foundation and the Thesis Award of the German Logistics Association (BVL). They have also contributed to published papers in conferences such as the IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), the International Symposium of Logistics (ISL) and the CIRP-sponsored International Conference on Changeable, Agile, Reconfigurable and Virtual Production (CARV).

1.2 Specific Advantages of the Industrial Engineering & Management Program at Constructor University

For the 2023/24 academic year, the program is offering two study modes: in-person and online. Students who opt for online study mode in Fall 2023 will have the opportunity to continue their studies online in the second and third years. The online mode involves participation in online modules that feature predominantly lectures and exercises, supplemented by tutorials.

Of the many reasons to enroll in the IEM program at Constructor University, these stand out:

- High-Quality Teaching:

  Our IEM faculty teaches students about current trends in industrial engineering and management using innovative teaching approaches. Small-to-medium laboratory classes, seminars and tutorials accompanying the lectures give space for effective learning and closer professor-student interaction, in person and online. Students are encouraged to ask questions and propose interesting topics. In-class exercises and case studies ensure an understanding of theoretical concepts and their applications, as well as an analysis of the current market and its issues. Moreover, during their studies, students also receive individual academic support and career advising.

- Lecturers from Renowned Industrial Companies:

  The IEM program incorporates several modules taught by lecturers from renowned German corporations, such as Porsche, Daimler, Schaeffler and 4flow. In their modules, lecturers teach theoretical concepts coupled with practical applications and examples from their company and the industry sector they are working in. Thus, students get to learn about the best practices of different industries directly from the experts.

- Practical Experience Through Internship Project:

  All students spend their fifth semester doing an internship lasting between four to six months, which enables them to acquire valuable practical experience and is an essential part of the IEM program. We have established close connections with numerous companies and organizations around the globe through our alumni community and Student Career Support (SCS)which also help students during their applications. These companies include Airbus, Amazon, Daimler, Barry Callebaut, KPMG, Ab-InBev, and Volkswagen.

- Hands-on Learning:

  Classes at Constructor University provide hands-on learning through interactive business games, case studies and creative group work. Another advantageous quality is the close cooperation with industries in the Bremen area and beyond. Field trips, real-world projects with companies and guest lectures offer in-presence students opportunities to not only gain insights into industrial processes but to understand the theory learnt in class on a practical case scenario. These also help students establish their first industry connections as well, useful for the Internship Project and professionally.

- Involvement in Research and Industrial Projects:

  Within the study program, IEM students can be actively involved in industrial and research projects carried out by the faculty. Our faculty has performed diverse consulting projects with several renowned industrial companies. Moreover, the IEM research activities at Constructor

University are focused on specific fields of industrial engineering, aiming at optimizing production and distribution systems in an increasingly globalized market.

- Networking Opportunities:

  Several explicit networking events are built into the program. They are provided in the form of (hybrid) career events, such as "IEM Internship Day", the annual Career Fair, company visits and field days. Moreover, Constructor University's international campus is the perfect environment for the in-presence IEM program, as our students are exposed to an intercultural setting that prepares them for a career in global industrial corporations.

- Data analysis, visualization and management tools:

  During the program, IEM students will learn to use statistical, data analysis and data visualization tools (e.g. Excel, Python, and R). In class, students will work with given datasets and practice with these tools to recognize when they are appropriate and thus, be able to use them for research analysis and presentations in both their theses and internships.

1.3 Program-specific Educational Aims

1.3.1 Qualification Aims

The Constructor University B.Sc. program in Industrial Engineering & Management aims to prepare young talents for careers at the interface between the management and engineering business functions and teaches them to adapt naturally to interdisciplinary and intercultural surroundings. The program covers the key industrial engineering and management frameworks, concepts and tools necessary to design, plan, control and manage industrial systems, thus preparing graduates for successful careers in industry.

Furthermore, by being part of an international community on campus and online, students can work with people from different nationalities and cultural background, thus learning to work in multinational teams. This will also contribute to their personal development, by shaping their attitudes while they learn to engage with different types of people as they will do later in their academic and professional endeavors.

1.3.2 Intended Learning Outcomes

By the end of this program, students will be able to:

1. apply knowledge of engineering, management, logistics, and mathematics to identify, formulate, and solve problems in the field of industrial engineering;
2. use current academic techniques, skills, and modern industrial engineering and management tools necessary for industrial practice (e.g. ABC/XYZ Analysis, Value Stream Mapping, Process Modeling and Simulation, Linear Programming, Demand Forecasting Methods, CAD drawings, Porter's 5 Forces, SWOT & PESTEL analyses, Business Model Canvas.);
3. create solutions to real industrial situations applying principles of industrial engineering, business administration, strategy, logistics and supply chain management (as seen in case studies and examples in class);
4. design and conduct experiments, as well as analyze and interpret data with the help of software (e.g. R) and programming languages (e.g. Python);

5. design a system or process to meet desired needs within realistic constraints, such as economic, environmental, social, health and safety, manufacturability, and sustainability constraints;
6. critically analyze industrial problems and make operational and strategic decisions involving complex or conflicting objectives;
7. discuss the financial issues of a project and provide structured management reports about project progress;
8. take on responsibility in and lead a diverse and multidisciplinary team consisting of both technical and management professionals;
9. professionally communicate their conclusions and recommendations in both spoken and written form, and convey the underlying information and their reasons to specialists and non-specialists both clearly and unambiguously based on the state of research and application;
10. discuss how the political, economic, social, and technological environments affect business functions in a globalized world;
11. use academic or scientific methods as appropriate in the field of industrial engineering and management, such as defining research questions, justifying methods, collecting, assessing and interpreting relevant information, and drawing scientifically-founded conclusions that consider social, scientific and ethical insights;
12. develop and advance solutions to problems and arguments in their subject area and defend these in discussions with specialists and non-specialists;
13. engage ethically with academic, professional, and wider communities and actively contribute to a sustainable future, reflecting and respecting different views;
14. take responsibility for their own learning, personal and professional development and role in society, evaluating critical feedback and self-analysis;
15. apply their knowledge and understanding to a professional context;
16. adhere to and defend ethical, scientific, and professional standards.

1.4 Career Options and Suport

Because of the incorporation of management and engineering modules, graduates of the IEM program get a wide spectrum of opportunities in both the professional and academic sectors. The profile of the B.Sc. Industrial Engineering & Management graduate is of great interest to national and international, medium and large-sized, trade and service industry companies. Graduates are especially qualified not only for for tasks in the fields of Logistics, Supply Chain Management (SCM), Procurement, Manufacturing and Automation, Process Optimization, and Information Technology (IT), but also for tasks from other engineering and management disciplines. The career paths that are open for graduates are as versatile as the major's theme. They range from specializations as experts in the production logistics areas through project management careers in different fields to consulting/auditing.

After graduation, students will excel at fulfilling various project responsibilities by applying the gained knowledge in the areas of manufacturing, distribution systems, supply chain management, project management, leadership, entrepreneurship, and team management. Close contacts are established with numerous companies both through field trips, networking events such as the Career Fair and guest lectures. These can help students obtain internships or jobs as graduates at enterprises such as Airbus, Amazon, Daimler, Barry Callebaut, Zalando, Röhlig, Porsche, Lufthansa Cargo, Hello Fresh, and KPMG.Past graduates have also chosen to continue their education by undertaking a graduate degree

at universities such as the University of Cambridge, Rotterdam School of Management, Vienna University of Economics and Business, Bocconi University, Dartmouth College, TU Munich, TU Berlin, and KU Leuven.

The Career Service Center (CSC) helps students in their career development. It provides students with high-quality training and coaching in CV creation, cover letter formulation, interview preparation, effective presenting, business etiquette, and employer research as well as in many other aspects, thus helping students identify and follow up on rewarding careers after graduating from Constructor University. Furthermore, the Alumni Office helps students establish a long-lasting and worldwide network which comes in handy when exploring job options in academia, industry, and elsewhere.

For further information, please contact the Career Service Center (CSC)

(https://constructor.university/student-life/career-services)

1.5 Admission Requirements

Admission to Constructor University is selective and based on a candidate's school and/or university achievements, recommendations, self-presentation, and performance on standardized tests. Students admitted to Constructor University demonstrate exceptional academic achievements, intellectual creativity, and the desire and motivation to make a difference in the world.

The following documents need to be submitted with the application:

- Recommendation Letter (optional)
- Official or certified copies of high school/university transcripts
- Educational History Form
- Standardized test results (SAT/ACT) if applicable
- Motivation statement
- ZeeMee electronic resume (optional)
- Language proficiency test results (TOEFL Score: 90, IELTS: Level 6.5 or equivalent)

Formal admission requirements are subject to higher education law and are outlined in the Admission and Enrollment Policy of Constructor University.

For more detailed information about the admission visit: https://constructor.university/admission-aid/application-information-undergraduate

1.6 More information and contacts

For more information on the study program please contact the Study Program Coordinator:

Dr. Stanislav Chankov

University Lecturer in Supply Chain Management

Email: schankov@constructor.university

or visit our program website: https://constructor.university/programs/undergraduate-education/industrial-engineering-management.

For more information on Student Services please visit:

https://constructor.university/student-life/student-services

2 The Curricular Structure

2.1 General

The curricular structure provides multiple elements for enhancing employability, interdisciplinarity, and internationality. The unique CONSTRUCTOR track, offered across all undergraduate study programs, provides comprehensive tailor-made modules designed to achieve and foster career competency. Additionally, a mandatory internship of at least two months after the second year of study and the possibility to study abroad for one semester give students the opportunity to gain insight into the professional world, apply their intercultural competences and reflect on their roles and ambitions for employment and in a globalized society.

All undergraduate programs at Constructor University are based on a coherently modularized structure, which provides students with an extensive and flexible choice of study plans to meet the educational aims of their major as well as minor study interests and complete their studies within the regular period.

The framework policies and procedures regulating undergraduate study programs at Constructor University can be found on the website (https://constructor.university/student-life/student-services/university-policies)

2.2 The Constructor University 4C Model

Constructor University offers study programs that comply with the regulations of the European Higher Education Area. All study programs are structured according to the European Credit Transfer System (ECTS), which facilitates credit transfer between academic institutions. The three-year undergraduate programs involve six semesters of study with a total of 180 ECTS credit points (CP). The undergraduate curricular structure follows an innovative and student-centered modularization scheme, the 4C Model. It groups the disciplinary content of the study program in three overarching themes, CHOICE-CORE-CAREER according to the year of study, while the university-wide CONSTRUCTOR Track is dedicated to multidisciplinary content dedicated to methods as well as intellectual skills and is integrated across all three years of study. The default module size is 5 CP, with smaller 2.5 CP modules being possible as justified exceptions, e.g., if the learning goals are more suitable for 2.5 CP and the overall student workload is balanced.

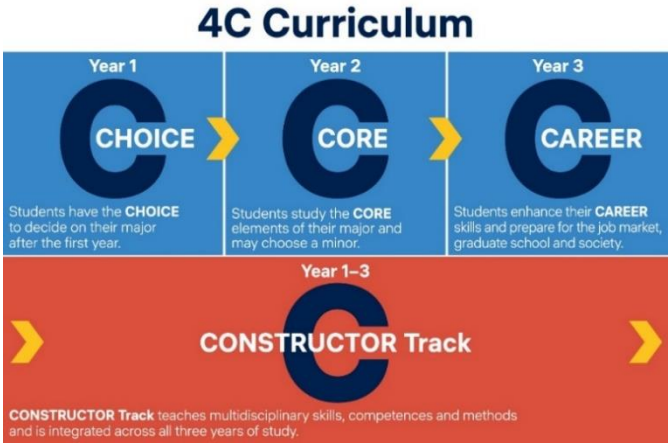

Figure 1: The Constructor University 4C-Model

2.2.1 Year 1 – CHOICE

The first study year is characterized by a university-specific offering of disciplinary education that builds on and expands upon the students' entrance qualifications. Students select introductory modules for a total of 45 CP from the CHOICE area of a variety of study programs, of which 15-45 CP will belong to their intended major. A unique feature of our curriculum structure allows students to select their major freely upon entering Constructor University. The team of Academic Advising Services offers curriculum counseling to all Bachelor students independently of their major, while Academic Advisors, in their capacity as contact persons from the faculty, support students individually in deciding on their major study program.

To pursue Industrial Engineering & Management as a major, students take the following mandatory (m) CHOICE modules (30 CP)

- CHOICE Module: General Logistics (m, 7.5 CP)
- CHOICE Module: General Industrial Engineering (m, 7.5 CP)
- CHOICE Module: Introduction to International Business (m, 7.5 CP)
- CHOICE Module: Introduction to Finance and Accounting (m, 7.5 CP)

Thus, students will learn the fundamentals of industrial engineering, industrial management, manufacturing technology, logistics systems, and supply chains as well as the important business functions in the globalized world.

The remaining CHOICE modules (15 CP) can be selected in the first year of studies according to interest and with the aim to allow a change of major until the beginning of the second year, when the major choice becomes fixed.

Students can still change to another major at the beginning of their second year of studies, provided they have taken the corresponding mandatory CHOICE modules in their first year of studies. All students must participate in an entry advising session with their Academic Advisors to learn about their major change options and consult their Academic Advisor prior to changing their major. (*Disclaimer: Major change options when entering the second year may differ for in-presence and online studies.)*

Students that would like to retain a further option are strongly recommended to additionally register for the CHOICE modules of one of the following study programs in their first year:

- International Business Administration (IBA) – also available for online students
  CHOICE Module: Microeconomics (m, 7.5 CP)
  CHOICE Module: Macroeconomics (m, 7.5 CP)
  CHOICE Module: Introduction to International Business (m, 7.5 CP)
  CHOICE Module: Introduction to Finance and Accounting (m, 7.5 CP)

- Global Economics and Management (GEM)
  CHOICE Module: Microeconomics (m, 7.5 CP)
  CHOICE Module: Macroeconomics (m, 7.5 CP)
  CHOICE Module: Introduction to International Business (m, 7.5 CP)
  CHOICE Module: Introduction to Finance and Accounting (m, 7.5 CP)

- Integrated Social and Cognitive Psychology (ISCP)
  CHOICE Module: Essentials of Cognitive Psychology (m, 7.5 CP)
  CHOICE Module: Essentials of Social Psychology (m, 7.5 CP)

2.2.2 Year 2 – CORE

In their second year, students will take a total of 45 CP from in-depth, discipline-specific CORE modules. Building on the introductory CHOICE modules and applying the methods and skills acquired so far (see 2.3.1), these modules aim to extend the students' critical understanding of the key theories, principles, and methods from both industrial engineering and management.
To pursue IEM as a major, at least the following mandatory CORE modules (30 CP) split in two units need to be taken:

1) "Advanced Industrial Engineering", consisting of the modules:

    - CORE Module: Process Modelling & Simulation (m, 5 CP)
    - CORE Module: Product & Production System Design (m, 5 CP)
    - CORE Module: Production Planning & Control (m, 5 CP)

This unit takes an in-depth look into production systems, providing the students with understanding of product development and design activities, production planning and control methods, as well as the modeling and simulation of the entire manufacturing processes.

2) "Advanced Industrial Management", consisting of the modules:

    - CORE Module: Operations Research (m, 5 CP)
    - CORE Module: Lean Supply Management (m, 5 CP)
    - CORE Module: Data Management and Analytics in Industry 4.0 (m, 5 CP)

In this unit, students will learn to model decision-making problems, to develop purchasing strategies, to employ advanced lean methods for the elimination of waste in industrial processes, and to manage innovation and technologies.

Students decide to complement their studies by taking the discipline-specific mandatory elective (me) CORE modules (15 CP) from the following unit:

3) "Project & Strategic Management**",** consisting of the modules:

    - CORE Module: Applied Project Management (me, 7.5 CP)
    - CORE Module: International Strategic Management (me, 7.5 CP)

or substitute these modules with CORE modules from other study programs according to interest and/or with the aim of pursuing a minor in a second field. (*Disclaimer: The minor option may differ for in-presence and online studies.)*

The "Project & Strategic Management" unit prepares students to set up, organize, manage and control projects as well as to evaluate and design strategies in international management.

IEM students can take CORE modules (or more advanced Specialization modules) from a second discipline, which allows them to incorporate a minor study track into their undergraduate education, within the 180 CP required for a bachelor's degree. The educational aims of a minor are to broaden students' knowledge and skills, support a critical reflection on statements in complex contexts, foster an interdisciplinary approach to problem-solving, and to develop an individual academic and

professional profile in line with students' strengths and interests. This extra qualification will be highlighted in the transcript.

The Academic Advising Coordinator, Academic Advisor, and the Study Program Chair of the minor study program support students in the realization of the minor option. In addition, the consultation with the Academic Advisor is mandatory when choosing a minor.

As a rule, this requires IEM students to:

- select CHOICE modules (15 CP) from the desired minor program in the first year and
- substitute mandatory elective IEM CORE modules (15 CP) in the second year with the default minor CORE modules of the minor study program.

The requirements for each specific minor are described in the handbook of the study program offering the minor (Chapter 3.2) and are marked in Study and Examination Plans of the respective programs. For an overview of accessible minors, please check the Major/Minor Combination Matrix which is published at the beginning of each academic year. Online students can only take the minor in Data Science.

2.2.3 Year 3 – CAREER

During their third year, IEM students prepare for and make decisions about their career after graduation. The third year also focuses on the responsibility of students beyond their discipline and in their fifth semester students will undertake an internship that prepares them for their careers. The sixth semester is dedicated to fostering the research experience of students by involving them in an extended Bachelor thesis project. In addition, in the sixth semester students also choose between different Specialization modules thus further developing their skills in the fields of product design, innovative technologies, or supply chain management and logistics by working on diverse and challenging projects and case studies.

2.2.3.1 Internship / Start-up and Career Skills Module

As a core element of Constructor University's employability approach students are required to engage in a mandatory internship. Gaining practical experience is especially important for the IEM program, therefore students will complete a four-month program-specific internship (30 CP) in the fifth semester of study. This curricular component gives students the opportunity to gain first-hand experience in a professional environment, apply their knowledge and understanding to a professional context, reflect on the relevance of their major to their career and society, reflect on their own role in their future working life and society, and find professional orientation. The internship can also establish a contact for the bachelor's thesis project or further employment after graduation. The module is completed by career advising and several career skills workshops throughout all six semesters which prepare students for the transition from student life to working life as well as for their future career.

As an alternative to the full-time internship, students interested in setting up their own company can apply for a startup option (15 CP) to focus on the development of their business plan. Students who take part in the start up option do a shortened full-time internship of minimum 8 weeks (15 CP) in the fifth semester.

For further information, please contact the Career Service Center (https://constructor.university/student-life/career-services).

2.2.3.2 Specialization Modules

In the third year of their studies, students take 15 CP from major-specific or major-related, advanced Specialization Modules to consolidate their knowledge and to be exposed to state-of-the-art research in the areas of their interest. This curricular component is offered as a portfolio of modules, from which students can make free selections during their fifth and sixth semester. The default Specialization Module size is 5 CP, with smaller 2.5 CP modules being possible as justified exceptions.

To pursue IEM as a major, at least 10 of the 15 CP from the following major-specific Specialization Modules need to be taken:

- IEM Specialization: Industry 4.0 and Blockchain Technologies (me, 5 CP)
- IEM Specialization: Advanced Product Design (me, 5 CP)
- IEM Specialization: Supply Chain Design (me, 2.5 CP)
- IEM Specialization: Integrated Decision Making in Supply Chain Management (me, 2.5 CP)
- IEM Specialization: Distribution & E-Commerce (me, 2.5 CP)
- IEM Specialization: Law of Transportation, Forwarding and Logistics (me, 2.5 CP)

The first two modules focus more on technology and design aspects, while the latter four modules provide a deeper look in different elements of supply chain management and logistics.

A maximum of 5 CP can be taken from the major-related course instead of major-specific Specialization Modules:

- RIS Specialization: Machine Learning (me, 5 CP)

Students may also select 15 CP entirely from their major-specific Specialization Modules.

2.2.3.3 Study Abroad

The curriculum of IEM does not define a certain mobility window for study abroad. Students who desire to pursue this option have the option of individually arranging their study abroad stay.

For further information, please contact the International Programs office (https://constructor.university/student-life/study-abroad/international-office).

2.2.3.4 Bachelor Thesis/Seminar Module

This module is a mandatory graduation requirement for all undergraduate students. It consists of two module components in the major study program guided by a Constructor University faculty member: the Bachelor Thesis (12 CP) and a Seminar (3 CP). The title of the thesis will appear on the students' transcripts.

Within this module, students apply the knowledge skills, and methods they have acquired in their major discipline to become acquainted with actual research topics, ranging from the identification of suitable (short-term) research projects, preparatory literature searches, the realization of discipline-specific research, and the documentation, discussion, and interpretation of the results.

With their Bachelor Thesis students demonstrate mastery of the contents and methods of their major-specific research field. Furthermore, students show the ability to analyze and solve a well-defined problem with scientific approaches, a critical reflection of the status quo in scientific literature, and the original development of their own ideas. With the permission of a Constructor University Faculty Supervisor, the Bachelor Thesis can also have an interdisciplinary nature. In the seminar, students present and discuss their theses in a course environment and reflect on their theoretical or experimental approach and conduct. They learn to present their chosen research topics concisely and comprehensively in front of an audience and to explain their methods, solutions, and results to both specialists and non-specialists.

2.3 The CONSTRUCTOR Track

The CONSTRUCTOR Track is another important feature of Constructor University's educational model. The Constructor Track runs orthogonal to the disciplinary CHOICE, CORE, and CAREER modules across all study years and is an integral part of all undergraduate study programs. It provides an intellectual tool kit for lifelong learning and encourages the use of diverse methodologies to approach cross-disciplinary problems. The CONSTRUCTOR track contains Methods, New Skills and German Language and Humanities modules.

2.3.1 Methods Modules

Methods and skills such as mathematics, statistics, programming, data handling, presentation skills, academic writing, and scientific and experimental skills are offered to all students as part of the Methods and Skills area in their curriculum. The modules that are specifically assigned to each study programs equip students with transferable academic skills. They convey and practice specific methods that are indispensable for each students' chosen study program. Students are required to take 20 CP in the Methods area. The size of all Methods modules is 5 CP.

To pursue IEM as a major, the following Methods modules (20 CP) need to be taken as mandatory modules:

- Methods Module: Applied Calculus (m, 5 CP)
- Methods Module: Finite Mathematics (m, 5 CP)
- Methods Module: Programming in Python (m, 5 CP)
- Methods Module: Applied Statistics with R (m, 5 CP)

The first two modules establish a good mathematics foundation, while the latter two modules prepare students to analyze and interpret data with the help of software (R) and programming languages (Python).

2.3.2 New Skills Modules

This part of the curriculum constitutes an intellectual and conceptual tool kit that cultivates the capacity for a particular set of intellectual dispositions including curiosity, imagination, critical thought, and transferability. It nurtures a range of individual and societal capacities, such as self-reflection, argumentation and communication. Finally, it introduces students to the normative aspects of inquiry and research, including the norms governing sourcing, sharing, withholding materials and research results as well as others governing the responsibilities of expertise as well as the professional point of view.

All students are required to take the following modules in their second year:

- New Skills Module: Logic (m, 2.5 CP)
- New Skills Module: Causation and Correlation (m, 2.5 CP)

These modules will be offered with two different perspectives of which the students can choose. The module perspectives are independent modules which examine the topic from different point of views. Please see the module description for more details.

2.3.3 German Language and Humanities Modules

German language abilities foster students' intercultural awareness and enhance their employability in their host country. They are also beneficial for securing mandatory internships (between the 2nd and 3rd year) in German companies and academic institutions. Constructor University supports its students in acquiring basic as well as advanced German skills in the first year of the Constructor Track. Non-native speakers of German are encouraged to take 2 German modules (2.5 CP each), but are not obliged to do so. Native speakers and other students not taking advantage of this offering take alternative modules in Humanities in each of the first two semesters:

- Humanities Module: Introduction to Philosophical Ethics (me, 2.5 CP)
- Humanities Module: Introduction to the Philosophy of Science (me, 2.5 CP)
- Humanities Module: Introduction to Visual Culture Bremen in the World (me, 2.5 CP)

3 Industrial Engineering & Management as a Minor

3.1 Educational Aims of this Program for Minor Students

3.1.1 Qualification Aims

The Constructor University minor in Industrial Engineering & Management aims to prepare young talents for careers at the interface between the management and engineering business functions. The program covers some of the key industrial engineering frameworks, concepts and tools necessary to design, plan, and control industrial systems.

3.1.2 Intended Learning Outcomes

By the end of this program, students will be able to

1. apply knowledge of engineering and logistics to identify, formulate, and solve problems in the field of industrial engineering;
2. use current academic techniques and skills, and modern industrial engineering tools necessary for industrial practice (e.g. ABC/XYZ Analysis, Process Modeling and Simulation, Demand Forecasting Methods, CAD drawings);
3. create solutions to real industrial situations applying principles of logistics and supply chain management (as seen in case studies and examples in class);

4. design a system or process to meet desired needs within realistic constraints, such as economic, environmental, social, health and safety, manufacturability, and sustainability constraints.

3.2 Module Requirements

A minor in IEM requires 30 CP. The default option for obtaining a minor in IEM is shown in the Study and Examination Plan. It includes the first-year unit "General Industrial Engineering and Logistics" and the second-year unit "Advanced Industrial Engineering" with the following CHOICE and CORE modules:

CHOICE Module: General Logistics (m, 7.5 CP)

CHOICE Module: General Industrial Engineering (m, 7.5 CP)

CORE Module: Process Modeling and Simulation (m, 5 CP)

CORE Module: Product & Production System Design (m, 5 CP)

CORE Module: Production Planning & Control (m, 5 CP)

3.3 Degree

After successful completion the minor in Industrial Engineering & Management will be listed on the final transcript under PROGRAM OF STUDY and BA/BSc – [name of the major] as "(Minor: Industrial Engineering and Management)".

4 Industrial Engineering & Management Undergraduate Program Regulations

4.1 Scope of these Regulations

The regulations in this handbook are valid for all students who entered the Industrial Engineering & Management undergraduate program at Constructor University in Fall 2023. In case of a conflict between the regulations in this handbook and the general Policies for Bachelor Studies, the latter apply (see https://constructor.university/student-life/student-services/university-policies)

In exceptional cases, certain necessary deviations from the regulations of this study handbook might occur during the course of study (e.g., change of the semester sequence, assessment type, or the teaching mode of courses).

In general, Constructor University reserves therefore the right to change or modify the regulations of the program handbook according to relevant policies and processes also after its publication at any time and in its sole discretion.

4.2 Degree

Upon successful completion of the study program, students are awarded a Bachelor of Science (BSc) degree in Industrial Engineering and Management.

4.3 Graduation Requirements

In order to graduate, students need to obtain 180 CP. In addition, the following graduation requirements apply: Students need to complete all mandatory components of the program as indicated in Chapter 2 of this handbook.

5 Schematic Study Plan for Industrial Engineering and Management

Figure 2 shows schematically the sequence and types of modules required for the study program. A more detailed description, including the assessment types, is given in the Study and Examination Plans in the following section.

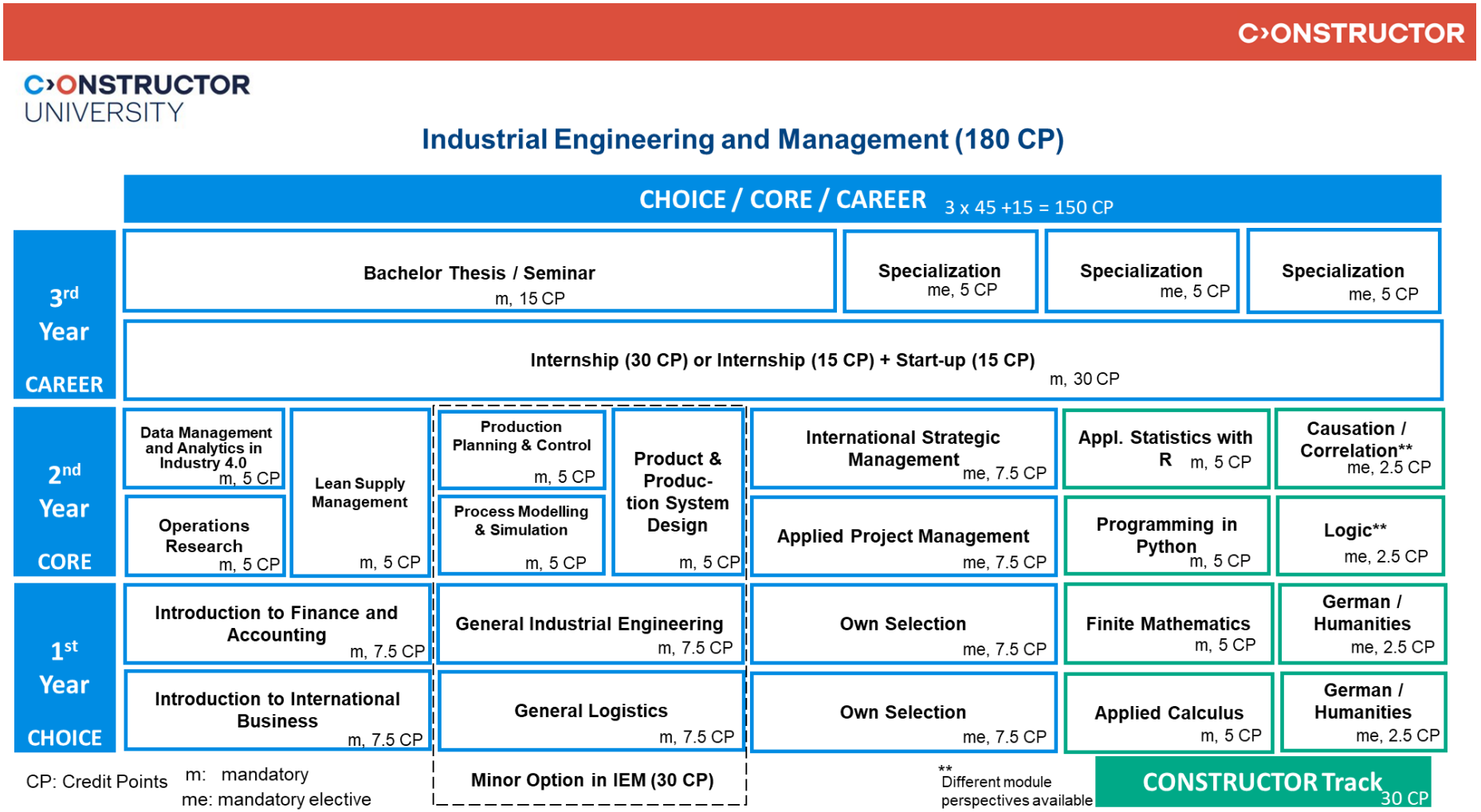

Figure 2: Schematic Study Plan for IEM

6 Study and Examination Plan

Industrial Engineering and Management (IEM) BSc

Matriculation Fall 2023

	Program-Specific Modules	Type	Assessment	Period	Status[1]	Sem.	CP
Year 1 - CHOICE							**45**
Take the mandatory CHOICE modules listed below, this is a requirement for IEM program.							
	Unit: General Industrial Engineering and Logistics (Default minor)						**15**
CH-241	**Module: General Logistics**				**m**	**1**	**7.5**
CH-241-A	Introduction to Logistics & Supply Chain Management	Lecture (in presence / online)	Written examination and Project Assessment	Examination period			5
CH-241-B	Logistics Lab	Lab (in presence / online)		During the semester			2.5
CH-240	**Module: General Industrial Engineering**				**m**	**2**	**7.5**
CH-240-A	Industrial Engineering	Lecture (in presence / online)	Written examination and Project Assessment	Examination period			5
CH-240-B	Basics of Manufacturing Technology	Lab (in presence / online)		During the semester			2.5
CH-300	**Module: Introduction to International Business**				**m**	**1**	**7.5**
CH-300-A	Introduction to International Business	Lecture (in presence / online)	Written examination	Examination period			5
CH-300-B	Introduction to International Business	Seminar (in presence / online)					2.5
CH-301	**Module: Introduction to Finance and Accounting**				**m**	**2**	**7.5**
CH-301-A	Introduction to Finance	Seminar (in presence / online)	Written examination	Examination period			2.5
CH-301-B	Introduction to Accounting	Seminar (in presence / online)					2.5
CH-301-C	Finance and Accounting Tutorial	Tutorial (in presence / online)					2.5
	Unit: CHOICE (own selection)					**1/2**	**15**
Take two further CHOICE modules from those offered for all other study programs.[2]							
Year 2 - CORE							**45**
Take all CORE modules listed in the first two units below. The modules in the unit Management can be substituted with default minor CORE modules of a minor study program.							
	Unit: Advanced Industrial Engineering (Default minor)						**15**
CO-582	**Module: Process Modelling & Simulation**				**m**	**3**	**5**
CO-582-A	Process Modelling & Simulation	Lab	Project assessment	During the semester			
CO-581	**Module: Product & Production System Design**				**m**	**3+4**	**5**
CO-581-A	Fundamentals of Engineering Design	Lab	Project Assessment	During the semester		3	2.5
CO-581-B	Advanced Production System Design	Lecture	Written examination	Examination period		4	2.5
CO-580	**Module: Production Planning & Control**				**m**	**4**	**5**
CO-580-A	Production Planning & Control	Lecture	Written examination	Examination period			
	Unit: Advanced Industrial Management						**15**
CO-583	**Module: Operations Research**				**m**	**3**	**5**
CO-583-A	Operations Research	Lecture	Written examination	Examination period			
CO-584	**Module: Lean Supply Management**				**m**	**3+4**	**5**
CO-584-A	Advanced Lean Methods	Seminar	Written examination and term paper	Examination period		3	2.5
CO-584-B	Purchasing & Supply Management	Seminar		During the semester		4	2.5
CO-586	**Module: Data Management and Analytics in Industry 4.0**				**m**	**4**	**5**
CO-586-A	Data Management and Analytics in Industry 4.0	Lecture	Project	During the semester			
	Unit: Management						**15**
CO-600	**Module: Applied Project Management**				**me**	**3**	**7.5**
CO-600-A	Applied Project Management	Lecture	Presentation	During the semester			5
CO-600-B	Applied Project Management	Seminar					2.5
CO-601	**Module: International Strategic Management**				**me**	**4**	**7.5**
CO-601-A	International Strategic Management	Lecture	Term paper	During the semester			5
CO-601-B	International Strategic Management	Seminar					2.5
Year 3 - CAREER							**60**
Module Code	**Module: Guided Industrial Project / Mandatory Internship**				**m**	**5**	**30**
CA-INT-901	Guided Industrial Project / Mandatory Internship	Internship	Project Report and poster Presentation	During the 5th semester			
CA-IEM-800	**Module: Thesis / Seminar IEM**				**m**	**6**	**15**
CA-IEM-800-T	Thesis IEM	Thesis	Thesis	15th of May			12
CA-IEM-800-S	Seminar IEM	Seminar	Presentation	During the semester			3
	Unit: Specialization IEM [3]				**m**	**6**	**15**
Take a total of 15 CP of specialization modules							
CA-S-IEM-801	**Industry 4.0 and Blockchain Technologies**				**me**		**5**
CA-S-IEM-801-A	Industry 4.0 Technologies	Lecture	Project Assessment	During the semester			
CA-S-IEM-801-B	Blockchain Applications in Industrial Engineering	Seminar					
CA-S-IEM-802	Advanced Product Design	Lab	Project Assessment	During the semester	me		5
CA-S-IEM-803	Supply Chain Design	Seminar	Project Assessment	During the semester	me		2.5
CA-S-IEM-804	Integrated Decision Making in Supply Chain Management	Seminar	Project Assessment	During the semester	me		2.5
CA-S-IEM-805	Distribution & E-Commerce	Lecture	Project Assessment	During the semester	me		2.5
CA-S-IEM-806	Law of Transportation, Forwarding and Logistics	Lecture	Written examination	Examination period	me		2.5

	CONSTRUCTOR Track Modules (General Educatio	Type	Assessment	Period	Status[1]	Sem.	CP
	Unit: Methods						**10**
Take all mandatory methods modules listed below.							
CTMS-MAT-08	**Module: Applied Calculus**				**m**	**1**	**5**
CTMS-08	Applied Calculus	Lecture (in presence / online)	Written examination	Examination period			
CTMS-MAT-11	**Module: Finite Mathematics**				**m**	**2**	**5**
CTMS-11	Finite Mathematics	Lecture (in presence / online)	Written examination	Examination period			
	Unit: German Language and Humanities (choose one module for each sememter)				**m**		**5**
German is open to Non-German speakers (on campus and online).[4]							
CTLA-	**Module: Language 1**				**me**	**1**	**2.5**
CTLA-	Language 1	Seminar (in presence / online)	Various	Various			
CTLA-	**Module: Language 2**				**me**	**2**	**2.5**
CTLA-	Language 2	Seminar (in presence / online)	Various	Various			
CTHU-HUM-001	**Humanities Module: Introduction to Philosophical Ethics**				**me**	**1**	**2.5**
CTHU-001	Introduction to Philosophical Ethics	Lecture (online)	Written examination	Examination period			
CTHU-HUM-002	**Humanities Module: Introduction to the Philosophy of Science**				**me**	**2**	**2.5**
CTHU-002	Introduction to the Philosophy of Science	Lecture (online)	Written examination	Examination period			
CTHU-HUM-003	**Introduction to Visual Culture**				**me**	**2**	**2.5**
CTHU-003	Introduction to Visual Culture	Lecture (online)	Written examination	Examination period			
							15
	Unit: Methods						**10**
CTMS-SKI-14	**Module: Programming in Python**				**m**	**3**	**5**
CTMS-14	Programming in Python	Lecture	Written examination	Examination period			
CTMS-MET-03	**Module: Applied Statistics with R**				**m**	**4**	**5**
CTMS-03	Applied Statistics with R	Lecture/Lab	Written examination	Examination period			
	Unit: New Skills						**5**
Choose one of the two modules							
CTNS-NSK- 01	**Module: Logic (perspective I)**				**me**	**3**	**2.5**
CTNS-01	Logic (perspective I)	Lecture (online)	Written Examination	Examination period			
CTNS-NSK-02	**Module: Logic (perspective II)**				**me**		**2.5**
CTNS-02	Logic (perspective II)	Lecture (online)	Written Examination	Examination period			
Choose one of the two modules							
CTNS-NSK-03	**Module: Correlation and Causation (perspective I)**				**me**	**4**	**2.5**
CTNS-03	Correlation and Causation (perspective I)	Lecture (online)	Written Examination	Examination period			
CTNS-NSK-04	**Module: Correlation and Causation (perspective II)**				**me**	**4**	**2.5**
CTNS-04	Correlation and Causation (perspective II)	Lecture (online)	Written Examination	Examination period			

Total CP		**180**

[1] Status (m = mandatory, me = mandatory elective)

[2] For a full listing of all CHOICE / CORE / CAREER / Constructor Track modules please consult the CampusNet online catalogue and/or the study program handbooks

[3] Note that 15 CP specialization modules need to be taken, of which a minimum of 10 CP must be major-specific and max. 5 CP can be major-related

[4] German native speakers have alternatives to the language courses (in the field of Humanities).

Figure 3: Study and Examination Plan

7 Industrial Engineering and Management Modules

7.1 General Logistics

<table>
<tr><td colspan="3">Module Name
General Logistics</td><td>Module Code
CH-241</td><td>Level (type)
Year 1 (CHOICE)</td><td>CP
7.5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CH-241-A</td><td colspan="3">Introduction to Logistics & Supply Chain Management</td><td>Lecture (in presence / online)</td><td>5</td></tr>
<tr><td>CH-241-B</td><td colspan="3">Logistics Lab</td><td>Lab (in presence / online)</td><td>2.5</td></tr>
<tr><td>Module Coordinator
Dr. Stanislav Chankov</td><td colspan="3">Program Affiliation
• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status
Mandatory for IEM and minor IEM
Mandatory elective for GEM</td></tr>
<tr><td colspan="3">Entry Requirements
Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• Basic spreadsheet software skills (e.g. MS Excel)</td><td>Frequency
Annually (Fall)

Duration
1 semester</td><td colspan="2">Forms of Learning and Teaching
• Lectures (35 hours)
• Labs (22.5 hours)
• Project work (30 hours)
• Private Study (100 hours)

Workload
187.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
Learn or practice basic functions in a spreadsheet software (e.g. MS Excel).</td></tr>
<tr><td colspan="6">Content and Educational Aims
The module consists of two module components, one lecture and one practical lab.

In the lecture, students will be introduced to the scope of logistics and supply chain management (SCM). They will get to understand the main logistics goals, processes, and functions as well as the recent and future challenges in logistics and supply chain management with regards to technical, economic, social and environmental factors. The focus is on providing a holistic perspective on three main areas of logistics and SCM: procurement, production, and distribution. Accordingly, the following subjects will be covered: overview of operative procurement, strategic sourcing, production planning and control, distribution logistics, inventory management, supply chain network design, and management of logistics service providers. The students are also given a project task on a specific topic, aimed at improving students' teamwork, project management and presentation skills.

The lab substantiates and amends the technical concepts taught in the lecture by exercises, experiments and/or simulations. These include exercises to demonstrate the principles of some logistics and industrial engineering methods (e.g., business process modeling, production planning, and linear programming). In addition, students will also gain practical knowledge by means of different business games. The Beer Distribution Game (a computer-based business game) will address the bullwhip</td></tr>
</table>

effect in supply chains and improve students' understanding of logistics and supply chain management. A case study based on The Fresh Connection game will prepare students to develop supply chain risk management strategies.

Intended Learning Outcomes

By the end of this module, students will be able to

1. describe the entire value-added chain from the supplier to the customer (the procurement, the production, the distribution and the reverse [waste management] logistics) and its impact on the economic success of the company and on society at large;
2. explain the definitions and terms commonly used in the logistics and supply chain management realm;
3. explain the linkages and differences between logistics and supply chain management;
4. discuss conflicting logistics and supply chain targets and their trade-offs from a holistic perspective;
5. describe the processes, strategies, and tools of procurement, production and distribution logistics;
6. model business processes with the event-driven process chain notation;
7. solve linear programming and transportation problems;
8. explain the reasons behind one of the main problems in supply chain management: the Bullwhip effect;
9. apply the main methods of analysis in logistics (e.g., ABC/XYZ analysis, Kraljic Matrix, throughput diagram, logistics operating curves, logistics potential analysis, storage model, safety stock calculation);
10. derive recommendations for mitigating short-, medium- and long-term supply chain risks
11. effectively work in teams to develop and deliver a presentation on a topic in the context of logistics and SCM.

Indicative Literature

DHL Trend Research (2019). Logistics Trend Radar, DHL Customer Solutions & Innovation, Troisdorf, Germany.

Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply chain management: more than a new name for logistics. The international journal of logistics management, 8(1), 1-14.

Benton, W. C. (2013). Purchasing and Supply Chain Management: Third Edition. McGraw-Hill Higher Education.

Nix, N. W. (2001). Purchasing in a supply chain context. Supply Chain Management, 205-235.

Nyhuis, P., & Wiendahl, H. P. (2008). Fundamentals of production logistics: theory, tools and applications. Springer Science & Business Media.

Nyhuis, P., & Wiendahl, H. P. (2006). Logistic production operating curves–basic model of the theory of logistic operating curves. CIRP Annals-Manufacturing Technology, 55(1), 441-444.

Rushton, A. et al. (2000). The Handbook of Logistics and Distribution Management. Kogan Page.

Andersen, M., & Skjoett-Larsen, T. (2009). Corporate social responsibility in global supply chains. Supply Chain Management: An International Journal,14(2), 75-86.

Usability and Relationship to other Modules

Examination Type: Module Component Examination

Component 1: Lecture

Assessment Type: Written examination Duration: 180 minutes

Weight: 67 %

Scope: Intended learning outcomes 1-10 of the module.

Component 2: Lab

Assessment Type: Project assessment (group assessment) Weight: 33 %

Scope: Intended learning outcomes 9-11 of the module.

Completion: To pass this module, the examination of each module component has to be passed with at least 45%.

7.2 General Industrial Engineering

<table>
<tr><td colspan="3">Module Name

General Industrial Engineering</td><td>Module Code

CH-240</td><td>Level (type)

Year 1 (Choice)</td><td>CP

7.5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CH-240-A</td><td colspan="3">Industrial Engineering</td><td>Lecture (in presence / online)</td><td>5</td></tr>
<tr><td>CH-240-B</td><td colspan="3">Basics of Manufacturing Technology</td><td>Lab (in presence / online)</td><td>2.5</td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr. Yilmaz Uygun</td><td colspan="2">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory for IEM and minor IEM

Mandatory elective for GEM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites
☒ None

Co-requisites
☒ None

Knowledge, Abilities, or Skills
☒ None</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lectures (35 hours)
• Labs (17.5 hours)
• Group work (45 hours)
• Private study (90 hours)

Workload

187.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Maynard, H.B. & Zandin K. B. (2001). Maynard's Industrial Engineering Handbook. McGraw Hill Professional, 5th Edition.

Salvendy, G. (2001). Handbook of Industrial Engineering – Technology and Operations Management. John Wiley & Sons, Inc; 3rd edition.</td></tr>
<tr><td colspan="6">The module gives a broad introduction to the industrial engineering field. Industrial engineering is an application-oriented scientific discipline that deals with the creation and management of systems that integrate people and materials and energy in productive ways. Thus, the lecture-based “Industrial Engineering” module component covers topics from developing a product to its final manufacturing by looking at closely related and intertwined aspects, ranging from product design to production process design. All these topics are organized in consecutive chapters. Here, the starting point is product development, where the process of how to efficiently develop a product prototype is shown. The course discusses the importance of materials and properties that meet the specified requirements, followed by a look at standard machine elements that facilitate the fabrication of a product.

Another important aspect is engineering drawings that help visualize the products, containing dimensions and materials. Besides product-related aspects, manufacturing machines and processes need to be chosen, and the required quantity must be calculated, which is covered in the “Manufacturing Processes” chapter. Here, the most common production technologies and the possibilities of the machinery used in the production processes in the engineering industry will be dealt with in detail. Manufacturing technologies and processes such as casting, milling, and welding will be addressed.

Additionally, manual work stations will be analyzed as well in order to understand ergonomic aspects. Once the required number of machines is given, they need to be mapped and aligned on the factory shop floor, which will be dealt with in</td></tr>
</table>

another chapter. After designing products and production processes, the actual manufacturing with receiving orders and scheduling them may take place. Course topics include bill of materials, route sheets, and schedules. The necessary methods will be presented in the "Production Planning and Control" chapter. Eventually, selected trends in manufacturing that help improve the daily work of an industrial engineer will be discussed.

The lab-based module component "Basics of Manufacturing Technology" allows students to apply their knowledge of the main topics covered by the lecture-based module component. Students will be given a comprehensive case study and work in groups to plan detailed real-case production scenarios for manufacturing customer end-products. They will learn how to assess the applicability of the most common production technologies and the possibilities of the machinery used in the production processes in the engineering industry. Topics in operations management, including manufacturing process flow, production planning, bill of materials, and factory layouts, will be addressed in the case studies as well.

Intended Learning Outcomes

By the end of this module, students will be able to

1. fully comprehend the main responsibilities of industrial engineering;
2. understand and manage the whole process from product design to manufacturing;
3. choose basic materials (e.g., steel) for different types of products;
4. prepare simple engineering drawings;
5. calculate the required number of machines for a given scope of manufacturing requirements;
6. understand the importance of ergonomics and ergonomic workplace design;
7. apply several scheduling techniques for production planning and control;
8. reflect on the applicability of current developments and trends in industrial engineering;
9. describe the main manufacturing processes such casting, milling, welding, grinding, and the state-of-the-art tools and technologies used in these processes;
10. apply the knowledge of manufacturing technologies in planning detailed real-case production scenarios (including the bill of material, types of machinery used, types of production processes used, anticipated production rates) for manufacturing customer end-products.

Indicative Literature

Maynard, H.B. & Zandin K. B. (2001). Maynard's Industrial Engineering Handbook. McGraw Hill Professional, 5th Edition.

Salvendy, G. (2001). Handbook of Industrial Engineering – Technology and Operations Management. John Wiley & Sons, Inc; 3rd edition.

Simmons, C.; Maguire, D.(2004). Manual of engineering drawing, 2nd Edition-Newnes.

Usability and Relationship to other Modules

Examination Type: Module Component Examination

Component 1: Lecture

Assessment Type: Written examination — Duration: 180 minutes

Weight: 67 %

Scope: Intended learning outcomes 1-9 of the module.

Component 2: Lab

Assessment Type: Project assessment (group assessment) — Weight: 33 %

Scope: Intended learning outcomes 9-10 of the module.

Completion: To pass this module, the examination of each module component has to be passed with at least 45%.

7.3 Introduction to International Business

<table>
<tr><td colspan="3">Module Name

Introduction to International Business</td><td>Module Code

CH-300</td><td>Level (type)

Year 1 (CHOICE)</td><td>CP

7.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CH-300-A | Introduction to International Business | Lecture (in presence / online) | 5
CH-300-B | Introduction to International Business - Seminar | Seminar (in presence / online) | 2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Christoph Lattemann</td><td colspan="3">Program Affiliation

• International Business Administration (IBA)</td><td colspan="2">Mandatory Status

Mandatory for GEM, IBA, IEM, MDDA and minor EIM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites

☒ None

Co-requisites

☒ None

Knowledge, Abilities, or Skills
• None</td><td>Frequency

Annually (Fall)

Duration
1 semester</td><td colspan="2">Forms of Learning and Teaching
• Lecture (35 hours)
• Seminar (17.5 hours)
• Private studies on cases (50 hours)
• Private studies on content (85 hours)

Workload
187.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

None.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module provides the basics needed for making informed and effective business decisions in today's global economy. It focuses on the domains of business such as international strategy and organizational structure, selecting and managing entry modes, developing and marketing products internationally and managing international operations. Issues of globalization, cross-cultural businesses, politics and law in business, economic systems and development, international trade, and international financial markets will also be covered. Upon completing the module, students will know how to use a number of international business analytical tools, and have experience with case study analysis: including, PEST, CAGE, International Market Selection and Modes of Entry. Global corporate social responsibility and sustainability issues will also be discussed.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. understand and describe the process of globalization and how it affects markets and production e.g. identify the two forces causing globalization to increase, identify the types of companies that participate in international business, describe the global business environment and identify its four main elements;
2. describe culture and explain the significance of both national culture and subcultures, identify the components of culture and the impact on business, describe the two main frameworks used to classify cultures and explain their practical use;
3. describe each main type of political system. Identify the origins of political risk and how managers can reduce its effects. List the main types of legal systems and explain how they differ. Describe the major legal and ethical issues facing international companies;</td></tr>
</table>

4. describe what is meant by a centrally planned economy and explain why its use is declining. Identify the main characteristics of a mixed economy and explain the emphasis on privatization. Describe the different ways to measure a nation's level of development;
5. discuss international trade and trade patterns. Explain absolute advantage and comparative advantage and identify their differences. Explain the factor proportions and international product life cycle theories as well as trade and national competitive advantage theories;
6. describe the political, economic, and cultural motives behind governmental intervention in trade. List and explain the methods governments use to promote and restrict international trade;
7. define regional economic integration and identify its five levels. Discuss the benefits and drawbacks associated with regional economic integration;
8. discuss international capital market, international bond, international equity, and Eurocurrency markets. Discuss the four primary functions of the foreign exchange market. Explain how currencies are quoted and the different rates given;
9. explain how exchange rates influence the activities of domestic and international companies. Identify the factors that help determine exchange rates and their impact on business;
10. identify international strategies and the corporate-level strategies that companies use;
11. discuss the important issues that influence the choice of organizational structure;
12. explain why and how companies use exporting, importing, and countertrade. Explain the various means of financing export and import activities. Describe the different contractual entry modes that are available to companies. Discuss the important strategic factors in selecting an entry mode;
13. explain the impact globalization is having on international marketing activities. Understand the various dimensions for developing international product, promotional, pricing and distribution strategies (4P's marketing mix);
14. use concepts, tools and frameworks and apply them in the international business context. Develop and improve your analytical and critical thinking skills by applying them to contemporary international business issues. Improve communication skills like reading, writing, speaking, and listening. Prepare and deliver oral presentations as well as written works either prepared individually or as a team. Improve your research skills by analyzing real business situations, identifying problems, evaluating and discussing options and prepare recommendations. These recommendations need to be fact-based, undertaken qualitative and quantitative analyses.

Indicative Literature

Peng, M., Meyer K. (2019). International Business, 3 ed, Boston: Cengage Learning EMEA.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination

Duration: 120 minutes
Weight: 100%

Scope: All intended learning outcomes

Module achievement: preparation of case studies is a prerequisite ("Studienbegleitleistung") for being admitted to the written examination.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.4 Introduction to Finance and Accounting

Module Name	**Module Code**	**Level (type)**	**CP**
Introduction to Finance and Accounting	CH-301	Year 1 (CHOICE)	7.5

Module Components

Number	Name	Type	CP
CH-301-A	Introduction to Finance	Seminar (in presence / online)	2.5
CH-301-B	Introduction to Accounting	Semina (in presence / online)r	2.5
CH-301-C	Finance and Accounting Tutorial	Tutorial (in presence / online)	2.5

Module Coordinator	**Program Affiliation**	**Mandatory Status**
Prof. Dr. Tilo Halaszovich	• International Business Administration (IBA)	Mandatory for GEM, IBA, IEM, MDDA and minor EIM

Entry Requirements			**Frequency**	**Forms of Learning and Teaching**
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring)	• Seminars (35 hours) • Tutorial (17.5 hours) • Private Study (135 hours)
☒ Introduction to International Business	☒ none	None.	**Duration** 1 semester	**Workload** 187.5 hours

Recommendations for Preparation

None

Content and Educational Aims

This module introduces students to basic financial and accounting techniques necessary to supplement business decision-making. The module is split into three sub-parts. The first part focuses on finance and investment and will provide students with the basics of corporate finance and investments. It will offer an overview of the different sources of finance from private and public sources and it will introduce the analytical tools and the necessary techniques for the financial management of a firm. It further provides the foundation for the basic domains of entrepreneurial finance, financing small- and medium enterprises and accessing capital markets. This also includes structuring financial activities in projects, funds, mergers and acquisition.

The second part focuses on measuring the financial position and performance of a firm, on reporting cash flows and on analyzing financial statements. The perspective, thereby, lies on purposes of accounting, principal accounting procedures, sources and recording of data, the verification of accounting records, principles of financial statements, preparation, analysis and interpretation of financial statements, international accounting standards (IFRS), and principles and policies and their differences.

The third part of the module is designed as tutorial. In the tutorial students will repeat, apply and practice the techniques from both seminars. Students work on exercises individually and in small groups.

Intended Learning Outcomes

By the end of this module, students will be able to

1. understand the theoretical foundation of corporate finance
2. understand how public and private financial markets and organizations work
3. differentiate the variety of financing sources for companies
4. develop a sound understanding how to structure investments
5. identify and explain the financial structure of firms
6. identify and describe the major functions of financial reporting
7. describe and explain the relationship between financial statement elements
8. describe the roles and desirable attributes of financial reporting standards
9. describe and explain the elements of the balance sheet
10. describe, explain and classify cash flow items
11. describe and explain tools and techniques used in financial analysis and calculate ratios
12. describe and explain characteristics of financial reporting quality

Indicative Literature

Phillips, F., Libby,R., Libby P. (2015). Fundamentals of Financial Accounting, 5th Edition. New York: McGraw-Hill Education.

Fraser, L.M., Ormiston, A. (2015). Understanding Financial Statements, 11th Edition, London: Pearson.

Hisrich, R., Peters, M., Shepherd D (2017). Entrepreneurship & Innovation, 10th Edition, New York: McGraw-Hill.

Usability and Relationship to other Modules

- Builds on the module "Introduction to International Business"
- The module prepares students for the CORE modules in the second and third study year

Examination Type: Module Examination

Assessment Type: Written examination — Duration: 120 minutes
Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.5 Process Modelling and Simulation

<table>
<tr><td colspan="3">Module Name

Process Modeling and Simulation</td><td>Module Code

CO-582</td><td>Level (type)

Year 2 (CORE)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CO-582-A | Process Modeling and Simulation | Lab | 5</td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr. Yilmaz Uygun</td><td colspan="2">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory for IEM and minor IEM</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
☒ General Industrial Engineering and General Logistics | ☒ None | ☒ None</td><td>Frequency

Annually

(Fall)</td><td colspan="2">Forms of Learning and Teaching

• Lectures (17.5 hours)
• Lab (17.5 hours)
• Group work (45 hours)
• Private Study (45 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Chung, C.A. (2004): Simulation Modeling Handbook – A Practical Approach. CRC Press. Boca Raton, FL.</td></tr>
<tr><td colspan="6">Process understanding is highly important in the field of industrial engineering and management. Without knowing processes, there is no opportunity to improve them. Various concepts of process modeling will be introduced, as well as modeling methods and modeling languages. The three most important modeling methods that will be covered in this module are discrete-event, agent-based, and system dynamics. Discrete-event simulation is widely used in industry for the design and analysis of logistical parameters, such as inventory levels, capacity utilization, lead times, and carbon footprint. Agent-based simulation helps model individual agents and their behavior to understand their effect and impact on the overall system. System dynamics, which helps to model a whole system on a highly aggregate level to understand its dynamics via feedback loops, will be dealt with.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. distinguish between the three simulation and modeling methods;
2. create discrete-event simulation models to analyze logistical parameters;
3. create agent-based models to understand the impact of individual behavior on the overall system;
4. create system dynamics models to understand the dynamics of a highly aggregate system;
5. analyze bottlenecks and find improvement potential.</td></tr>
<tr><td colspan="6">Indicative Literature

Chung, C.A. (2004). Simulation Modeling Handbook – A Practical Approach. CRC Press. Boca Raton, FL.</td></tr>
</table>

Usability and Relationship to other Modules

- The module builds on the 1st -year IEM CHOICE modules General Industrial Engineering and General Logistics.

Examination Type: Module Examination

Assessment Type: Project assessment (group assessment) Weight: 100%

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%.

7.6 Product & Production System Design

<table>
<tr><td colspan="3">Module Name

Product & Production System Design</td><td>Module Code

CO-581</td><td>Level (type)

Year 2 (CORE)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CO-581-A</td><td colspan="3">Fundamentals of Engineering Design</td><td>Lab</td><td>2.5</td></tr>
<tr><td>CO-581-B</td><td colspan="3">Advanced Production System Design</td><td>Lecture</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Yilmaz Uygun</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory for IEM and minor IEM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites

☒ General Industrial Engineering

Co-requisites

☒ None

Knowledge, Abilities, or Skills

• Basic spreadsheet software skills (e.g. MS Excel)</td><td>Frequency

Annually

(Fall)

Duration

2 semesters</td><td colspan="2">Forms of Learning and Teaching

• Lectures (17.5 hours)
• Labs (17.5 hours)
• Group work (45 hours)
• Private study (45 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Revise the material from the General Industrial Engineering module on technical drawings and production system design.</td></tr>
<tr><td colspan="6">Content and Educational Aims

The first module component, “Fundamentals of Engineering Design”, will continue the basics taught in the General IEM module regarding technical drawing and sketching. Students will learn how to use CAx, computer-aided technologies, that aid in the design, analysis, and manufacture of products. Through exercises that include sketching (both manually and virtually) and creating simple prototypes, students will learn how to apply methods for 3D modelling software (e.g. Onshape). Moreover, students will use an Engineering Journal in order to learn to keep an organized record of their engineering drawings and prototypes.

The module component “Advanced Production System Design” will introduce students to advanced methods of production system design. The lecture combines theoretical knowledge and hands-on exercises. Students will be introduced to different production organization forms in different industries. Students learn to analyze products, calculate the required number of machines, cluster those to machine groups, determine space requirements, lay them out, and design work stations with the Methods-Time Measurement (MTM) technique.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. become familiar with the design process and learn creative approaches to problem solving;
2. produce 3D modelling parts, assemblies, and technical drawings using a 3D modeling software;
3. become proficient in record keeping through the use of an Engineering Journal;
4. apply CAx systems to design simple product prototypes;
5. analyze product portfolios as to their cost structures and profit contribution using clustering techniques (e.g., ABC, XYZ)
6. calculate the required number of machines for a given scope of manufacturing requirements;
7. cluster and define machine groups using clustering techniques;
8. design a proper layout for the selected machines;
9. design a manual workstation using the MTM method.

Indicative Literature

Hopp, W.J. & Spearman, M.L. (2011).Factory Physics. 3rd Edition, Waveland Publishing.

Architecture Technology Corp (1991). Computer Aided Process Planning (CAPP), Elsevier Advanced Technology.

Altintas, Y. (2012). Manufacturing automation metal cutting mechanics, machine tool vibrations, and CNC design, Cambridge University Press.

Groover, M. (1996). Fundamentals of modern manufacturing, Wiley.

Usability and Relationship to other Modules

- The module builds on the 1st-year IEM CHOICE module General Industrial Engineering.

Examination Type: Module Component Examinations

Component 1: Lab

Assessment Type: Project Assessment

Weight: 50%

Scope: Intended learning outcomes 1-4 of the module

Component 2: Lecture

Assessment Type: Written Examination Duration: 90 minutes

Weight: 50%

Scope: Intended learning outcomes 5-9 of the module

Completion: To pass this module, the examination of each module component has to be passed with at least 45%

7.7 Production Planning & Control

<table>
<tr><td colspan="3">Module Name
Production Planning and Control</td><td>Module Code
CO-580</td><td>Level (type)
Year 2 (CORE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components
Number | Name | Type | CP
CO-580-A | Production Planning and Control | Lecture | 5</td></tr>
<tr><td colspan="2">Module Coordinator
Prof. Dr.-Ing. Hendro Wicaksono</td><td colspan="2">Program Affiliation
• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status
Mandatory for IEM and minor IEM</td></tr>
<tr><td colspan="3">Entry Requirements
Pre-requisites: ☒ General Logistics
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: Basic spreadsheet software skills (e.g. MS Excel)</td><td>Frequency
Annually
(Spring)
Duration
1 semester</td><td colspan="2">Forms of Learning and Teaching
• Lecture (35 hours)
• Private Study (90 hours)
Workload
125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
Hopp, W. J. & Spearman, M. L., Factory Physics: Foundations of Manufacturing Management, 3rd edition, Waveland Press Inc., 2011.
Jacobs, F. R. & Chase, R. C., Operations and Supply Chain Management, 15th edition, McGraw-Hill, 2018.</td></tr>
<tr><td colspan="6">Content and Educational Aims
A thorough introduction of the planning and control basics and their coherences with the essential processes of the order management within production companies as well as the co-ordination of the entire manufacturing processes will be given in this lecture. The module presents the problems that production companies are confronted with. Further, students gain a profound understanding of the objectives of production logistics, the modeling methods of production systems, and the production planning and control (PPC) tasks, i.e. demand forecasting, capacity planning, aggregate and workforce planning, material requirement planning, lot sizing, sequencing and scheduling, shop floor control, and production tracking. Various mathematical and statistical methods are integrated in this lecture. Furthermore, new production requirements, such as green production, and mass customization and their impacts on PPC tasks will be discussed.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes
By the end of this module, students will be able to
1. explain the objectives of production systems, their trade-offs, and the role of production planning and control (PPC);
2. apply production planning and control (PPC) frameworks, including activities such as forecasting, capacity, workforce, aggregate planning, scheduling and sequencing, shop floor control, and production tracking;
3.apply mathematical and statistical methods, such as linear programming, linear regression, decision tree, etc., to solve production planning and control problems;
4.independently develop concepts to apply new technologies to improve PPC activities;</td></tr>
</table>

5.demonstrate the impacts of new production requirements on PPC activities, such as green production and lot size one production;
6.give an outlook on the trends of PPC and the roles of IT systems.

Indicative Literature

Hopp, W. J. & Spearman, M. L. (2001). Factory Physics: Foundations of Manufacturing Management, 3rd edition, Waveland Press Inc.

Jacobs, F. R. & Chase, R. C. (2018). Operations and Supply Chain Management, 15th edition, McGraw-Hill.

Usability and Relationship to other Modules

- The module builds on the 1st-year IEM CHOICE module Introduction to Logistics & Supply Chain Management.
- The module builds on the 1st-year IEM CHOICE module General Logistics.

Examination Type: Module Examination

Assessment Type: Written examination Duration: 120 minutes
Weight: 100 %

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%.

7.8 Operations Research

<table>
<tr><td colspan="3">Module Name

Operations Research</td><td>Module Code

CO-583</td><td>Level (type)

Year 2 (CORE)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CO-583-A | Operations Research | Lecture | 5</td></tr>
<tr><td>Module Coordinator

Dr. Stanislav Chankov</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory for IEM

Mandatory elective for RIS</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: Basic spreadsheet software skills (e.g. MS Excel)
basic calculus and matrix algebra
basic knowledge in logistics</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lectures (35 hours)
• Private Study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Revise basic calculus, matrix algebra and spreadsheet software functions.</td></tr>
<tr><td colspan="6">Content and Educational Aims

Operations research is an interdisciplinary mathematical science that focuses on the effective use of technology by organizations. By employing techniques such as mathematical modeling, statistical analysis, and mathematical optimization, operations research finds optimal or near-optimal solutions to complex decision-making problems. Operations Research is concerned with determining the maximum (of profit, performance, or yield) or the minimum (of loss, risk, or cost) of some real-world objective. This module introduces students to the modelling of decision problems and the use of quantitative methods and techniques for effective decision-making.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. calculate optimal or near-optimal solutions to complex decision-making problems using operations research methods;
2. design mathematical models for business problems;
3. apply techniques such as linear programming, dynamic programming or stochastic programming to solve business problems;
4. resolve common network optimization problems such as transportation, shortest path, minimum spanning tree, and maximum flow problems.</td></tr>
<tr><td colspan="6">Indicative Literature

Hillier, F. S. & Lieberman, G.J. (2009). Introduction to Operations Research. McGraw-Hill. New York, NY.</td></tr>
<tr><td colspan="6">Usability and Relationship to other Modules</td></tr>
</table>

- Serves as a 3rd-year Specialization module for major students in RIS

Examination Type: Module Examination

Assessment Type: Written examination

Duration: 120 minutes
Weight: 100 %

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.9 Lean Supply Management

<table>
<tr><td colspan="3">Module Name
Lean Supply Management</td><td>Module Code
CO-584</td><td>Level (type)
Year 2 (CORE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CO-584-A</td><td colspan="3">Advanced Lean Methods</td><td>Seminar</td><td>2.5</td></tr>
<tr><td>CO-584-B</td><td colspan="3">Purchasing & Supply Management</td><td>Seminar</td><td>2.5</td></tr>
<tr><td colspan="2">Module Coordinator
Dr. Stanislav Chankov</td><td colspan="2">Program Affiliation
• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status
Mandatory for IEM students</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites
☒ General Industrial Engineering, General Logistics, Introduction to International Business

Co-requisites
☒ None

Knowledge, Abilities, or Skills
☒ None</td><td>Frequency
Annually
(Fall)

Duration
2 semesters</td><td colspan="2">Forms of Learning and Teaching
• Seminars (35 hours)
• Private Study (90 hours)

Workload
125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Revise material from the 1st year related to lean methods and purchasing.</td></tr>
<tr><td colspan="6">Content and Educational Aims

The module consists of two module components. The first module component, Advanced Lean Methods, gives a micro perspective focused on a company's processes and decisions. The second module component, Purchasing & Supply Management, provides a macro perspective of the market and how the decision of one supplier can affect the rest of the supply chain, prices, and even demand. Both module components complement students' knowledge regarding processes, inside and outside of a company respectively.

The first module component, Advanced Lean Methods deals with the implementation and amplification of 20th-century lean methods in modern manufacturing processes associated with the kaizen philosophy. These include change management process, elimination of waste, one piece flow, pull principle, value stream mapping, 6 sigma, and zero defects. The module component provides a theoretical overview of these methods and enables students to apply them in practice by participating in game-based activities in class. The module component is heavily focused on the applicability of lean methods, providing numerous examples from the industry. Specifically, students apply the value stream mapping method to a real-world case study.

The second module component, Purchasing & Supply Management deals with purchasing and supply management practices. The costs of procuring materials or services can represent a large portion of an enterprise's total costs. Hence, purchasing and supply management are of crucial importance for the overall success of the company. In this module component, students learn via case studies how to develop the right purchasing strategy for each material segment and how to select the right supplier for each material. Other topics include behavioral aspects of purchasing, negotiation, buyer–supplier relationships, supplier integration, supplier quality management, working capital management, and innovation sourcing.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. evaluate as-is processes and suggest improvements based on the kaizen philosophy
2. identify different waste types in industrial processes and identify ways to eliminate the waste;
3. explain main lean methods;
4. apply value stream mapping to industrial processes;
5. develop a sourcing strategy for specific material categories;
6. explain how behavioral aspects play a role in buyer-supplier interactions;
7. design a negotiation strategy based on buyer-supplier power positioning;
8. apply quality management methods to ensure good supplier quality.

Indicative Literature

Benton, W. C. (2013). Purchasing and Supply Chain Management: Third Edition. McGraw-Hill Higher Education (McGraw-Hill/Irwin series operations and decision sciences).

Monczka, R. M. et al. (2015). Purchasing and Supply Chain Management. Cengage Learning.

Ohno, T. (1988). Toyota Production System: Beyond Large-Scale Production. Boca Raton, FL: Taylor & Francis (Productivity Press).

Womack, J. P., Jones, D. T. and Roos, D. (2007). The Machine That Changed the World: The Story of Lean Production-- Toyota's Secret Weapon in the Global Car Wars That Is Now Revolutionizing World Industry. Free Press.

Usability and Relationship to other Modules

- Elective for all other undergraduate study programs.

Examination Type: Module Component Examinations

Component 1: Seminar 1

Assessment Type: Written examination — Duration: 60 minutes, Weight: 50 %

Scope: Intended learning outcomes 1-4 of the module.

Component 2: Seminar 2

Assessment Type: Term paper — Length: 2.000 words, Weight: 50 %

Scope: Intended learning outcomes 5-8 of the module.

Completion: To pass this module, the examination of each module component has to be passed with at least 45%

7.10 Data Management and Analytics in Industry 4.0

<table>
<tr><td colspan="3">Module Name</td><td>Module Code</td><td>Level (type)</td><td>CP</td></tr>
<tr><td colspan="3">Data Management and Analytics in Industry 4.0</td><td>CO-586</td><td>Year 2 (Core)</td><td>5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP90</td></tr>
<tr><td>CO-586-A</td><td colspan="3">Data Management and Analytics in Industry 4.0</td><td>Lecture</td><td>5</td></tr>
<tr><td>Module Coordinator

Prof. Dr.-Ing. Hendro Wicaksono</td><td colspan="3">Program Affiliation

▪ Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory for IEM students</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites

☒ General Industrial Engineering

☒General Logistics

Co-requisites

☒ None

Knowledge, Abilities, or Skills

Basic IT and programming understanding</td><td>Frequency

Annually (Spring)</td><td colspan="2">Forms of Learning and Teaching

• Lecture (27.5 hours)
• Seminar (7.5 hours)
• Privat Study (30 hours)
• Group Work (60 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

▪ Basic Python/R programming
▪ Basic functions in a spreadsheet software (e.g. MS Excel)</td></tr>
<tr><td colspan="6">Content and Educational Aims

In recent years, big data has become a significant topic in the context of industry 4.0 since the amount of generated data in practices has grown exponentially. It is because of the introduction of internet of things and digital transformation in almost all industrial sectors including production and logistics. The big data is characterized with large size, high generation and transfer velocity, high variety of formats, and veracity that is difficult to validate. The data cannot be managed with conventional methods and tools. To get values from the data or to transform the data into knowledge that can be useful for industrial process optimization, data management and analytics are required. Knowledge management methods are also required to make sure that the resulting knowledge can be shared, applied, and preserved.

The module focuses on the data management and analytics methods that covers the following topics:

• Data modelling using graphical notations
• Data management with SQL
• Data analytics including techniques that apply data mining, statistical analysis, time series analysis, machine learning, etc. to uncover hidden patterns, correlations, trends, and other business valuable information and knowledge from data
• Knowledge management approach to manage knowledge resulting from data analytics
• Use cases in different industrial sectors, especially in production and logistics
• Development of innovation and business models for data-driven services</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. identify scenarios in industry 4.0 and evaluate the opportunities and challenges of data management and analytics applications
2. apply data modelling approaches using graphical notations and data management approaches using SQL tools
3. determine the objective of data analytics in different industrial scenarios and the data sources required to achieve the objectives
4. apply methods and tools to collect and to integrate data from different sources using linked data
5. apply machine learning and statistical analytics methods and tools to uncover hidden patterns, correlations, trends, and knowledge that are useful to improve supply chain management processes.
6. evaluate data analytics results in different industrial scenarios and solve the problems that might occur during the whole data analytics processes from data collection to analytics
7. apply knowledge management methods using ontologies
8. develop innovation and business models as well as the related ecosystem concepts for data-driven services

Indicative Literature

Ustundag, Alp, Cevikcan, Emre (2018). Industry 4.0: Managing The Digital Transformation, Springer, ISBN 978-3-319-57870-5

Allemang, Dean; Hendler, James (2008). Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL, Morgan Kaufmann, ISBN: 978-0123735560

Bruce, Peter; Bruce, Andrew (2017). Practical Statistics for Data Scientists, O'Reilly Media, ISBN: 9781491952962

Osterwalder, Alexander; Pigneur, Yves (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley and Sons, ISBN: 978-0470876411

Schilling, Melissa (2019). Strategic Management of Technological Innovation, McGraw-Hill Education 6th Edition, ISBN: 978-1260087956

Tidd, Joe; Bessant, John R. (2018). Managing Innovation: Integrating Technological, Market and Organizational Change, 6th Edition, Wiley, ISBN: 978-1-119-37945-4

Vasilik, Sylvia Moestl (2017). SQL Practice Problems: 57 beginning, intermediate, and advanced challenges, ISBN: 978-1520807638

Usability and Relationship to other Modules

Examination Type: Module Examination

Weight: 100%

Assessment Type: Project assessment (group assessment)

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%.

7.11 Applied Project Management

<table>
<tr><td colspan="3">Module Name

Applied Project Management</td><td>Module Code

CO-600</td><td>Level (type)

Year 2 (Choice)</td><td>CP

7.5</td></tr>
<tr><td colspan="6">Module Components

<table>
<tr><td>Number</td><td>Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CO-600-A</td><td>Applied Project Management</td><td>Lecture</td><td>5</td></tr>
<tr><td>CO-600-B</td><td>Applied Project Management - Seminar</td><td>Seminar</td><td>2.5</td></tr>
</table></td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr.-Ing. Steffen Christoph Eickemeyer</td><td colspan="2">Program Affiliation

• International Business Administration (IBA)</td><td colspan="2">Mandatory Status

Mandatory for minor EIM
Mandatory elective for IBA and IEM</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites

☒ Introduction to Internatioanal Business and Introduction to Finance and Accounting

Co-requisites

☒ None

Knowledge, Abilities, or Skills

None</td><td>Frequency

Annually (Fall)</td><td colspan="2">Forms of Learning and Teaching

• Lecture (35 hours)
• Seminar (17.5 hours)
• Private Study (135 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

187.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Before the first session, students should read: Luecke, R. (2004) : Managing Projects Large and Small - The Fundamental Skills for Delivering on Budget and on Time, Harvard Business School Press.</td></tr>
<tr><td colspan="6">Course Description / Content / Aims

Well-run projects depend entirely on the foundation laid in the initial planning stages, the care and precision of project organization, and excellent teamwork. The module Applied Project Management (APM) offers a detailed look at the characteristics of projects and a hands-on team simulation of the project planning and management process.

The APM module explains various project phases, including major and detailed tasks. It will deal with task assignment and resource allocation, budgeting, tracking, and scheduling techniques as well as with project leadership and team processes. The course will give students hands-on experience with project management, as students have to run a project on their own in teams over the semester.
The lecture component of this module covers the theoretical basics and offers practical examples. The seminar component of this module serves as an exercise based on examples and case studies, which are also carried out over the course hours in homework.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes
By the end of this module, students will be able to

1. identify and memorize the key skills to manage projects, including internationally accepted standards and procedures for runing and controling projects;
2. apply project management skills to set up, organize, manage and control (real) projects;
3. analyze project performance;
4. develop strong analytical and presentation skills.</td></tr>
</table>

Indicative Literature

Bittner, E., Gregorc, W. (ed.) (2010). Experiencing Project Management: Projects, Challenges and Lessons Learned. Hoboken: John Wiley & Sons.

Larson, E. W., Gray, C. F. (2015). A guide to the project management body of knowledge: PMBOK (®) guide. In: Project Management Institute.

Luecke, R (2004). Managing projects large and small: the fundamental skills for delivering on budget and on time. Harvard: Harvard Business Press.

Marks, T. (2012). 20:20 Project Management: How to deliver on time, on budget and on spec. London: Kogan Page Publishers.

Larson, E.W.; Gray, C. (2017). Project management: the managerial process, 7th edition. New York: McGraw-Hill Education.

Moriis, P.W.G., Pinto, J. K, Söderland, Jonas (Hg.) (2012). The Oxford handbook of project management. Oxford: Oxford University Press.

Pries, K. H.; Quigley, J.M (2010). Scrum project management. Boca Raton: CRC press.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Presentation

Duration: 45 minutes
Weight: 100%

Scope: All intended learning outcomes

Completion: To pass this module, the examination has to be passed with at least 45%.

7.12 International Strategic Management

<table>
<tr><td colspan="3">Module Name

International Strategic Management</td><td>Module Code

CO-601</td><td>Level (type)

Year 2 (CORE)</td><td>CP

7.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CO-601-A | International Strategic Management | Lecture | 5
CO-601-B | International Strategic Management - Seminar | Seminar | 2.5</td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr. Tilo Halaszovich</td><td colspan="2">Program Affiliation

• International Business Administration (IBA)</td><td colspan="2">Mandatory Status

Mandatory minor EIM
Mandatory elective for IBA and IEM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites

☒ Introduction to International Business and Introduction to Finance and Accounting

Co-requisites

☒ None

Knowledge, Abilities, or Skills

Academic writing skills
Good understanding of the principles of international management</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture (35 hours)
• Seminar (17.5 hours)
• Private Studies (135 hours)

Workload

187.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Students should have developed a sound understanding of the principles of international management. In this advanced module, these principles are not repeated but are used as a basis. It is strongly recommended for all students to refresh their knowledge of the CHOICE module Introduction to International Business.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module will explore the nature of strategy, the forces of competition and strategic decision-making in a globalized world. The module covers the principles of both business-level and corporate-level strategies in international organizations. It is designed to introduce a wide variety of modern strategy frameworks and methodologies, including methods of assessing the attractiveness of foreign markets, and the strength of competition, for understanding relative bargaining power, for anticipating competitors' actions, and for analyzing cost and value structures in global supply chains.

The lecture part of this module conveys the relevant concepts and theories of international strategic management in an interactive manner. In the seminar part, students will apply this knowledge to real world challenges in international strategic management.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. identify and explain critical challenges in strategic management;
2. develop a sound understanding of the mechanisms behind international strategic assessments and planning processes;
3. evaluate and design strategies in international management, such as market selection or entry mode choices;
4. acquire and develop t additional knowledge and skills needed to support strategic decision making in international firms;
5. utilize analytical skills and apply relevant tools as required in the discipline.</td></tr>
<tr><td colspan="6">Indicative Literature</td></tr>
</table>

Verbeke, A. (2013). International Business Strategy – 2nd edition. Cambridge: Cambridge: University Press.

Morschett, D., Schramm-Klein, H. & Zentes, J. (2015). Strategic International Management – 3rd edition. Wiesbaden: Springer Gabler.

Usability and Relationship to other Modules

- This module prepares students for the Bachelor Thesis focusing on topics in international management

Examination Type: Module Examination

Assessment Type: Term Paper Length: 4.000 words
Weight: 100%

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%.

7.13 Industry 4.0 and Blockchain Technologies

<table>
<tr><td colspan="3">Module Name

Industry 4.0 and Blockchain Technologies</td><td>Module Code

CA-S-IEM-801</td><td>Level (type)

Year 3 (Specialization)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CA-IEM-801-A</td><td colspan="3">Industry 4.0 Technologies</td><td>Lecture</td><td>2.5</td></tr>
<tr><td>CA-IEM-801-B</td><td colspan="3">Blockchain Applications in Industrial Engineering</td><td>Seminar</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr.-Ing. Hendro Wicaksono</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory elective for IEM</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites

☒ Data Management and Analytics in Industry 4.0

☒ Product & Production System Design

Co-requisites

☒ None

Knowledge, Abilities, or Skills

☒ None</td><td>Frequency

Annually (Spring)</td><td colspan="2">Forms of Learning and Teaching

• Lecture (17.5 hours)
• Seminar (17.5 hours)
• Private Study and Project Work (90 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Learn or practice basic functions in SQL database.</td></tr>
<tr><td colspan="6">Content and Educational Aims

The module component “Industry 4.0 Technologies” gives an introduction about the Industry 4.0 paradigm. The transformative role of this paradigm will be elaborated for students especially with focus on production & logistic system. The course will introduce the characteristics of Industry 4.0 and provides different scenarios which compare the pre-industry 4.0 and industry 4.0 capabilities in increasing productivity. By describing and bringing different example scenarios in Logistics, production & manufacturing, logistics operation consultancy, product engineering management and Technology management sectors, the application of Industry 4.0 discussed with class audiences. The main headlines in the module will be: Digital Twins, with emphasize with Manufacturing Resource Virtualization (Creating and connecting Database structures for resources and real-time data communication), Cloud manufacturing and Cloud Service matching (Resource, Task, Service Graph generation, Matching algorithm development), IoT and Real-time Interaction, Semantic Interoperability (Behavior Interoperability and Real-time interaction and adaptive planning), MES and SCADA & data interoperability (IEC61131-3), Blockchain Technology and Decentralization (Comparing distributed and Centralized adaptive planning).

In the “Blockchain Applications in Industrial Engineering” module component, students will learn and experience the blockchain approach. The potential of blockchain technology for the field of industrial engineering will be discussed and different blockchain applications in this field will be presented. This module covers private blockchains (i.e., applications in industrial engineering) and public blockchains (e.g., token-based blockchains and cryptocurrencies). During the module, a</td></tr>
</table>

project will be carried out covering the design, development, and implementation of a blockchain simulation. With the support of the lecturer, the students create a simulation on a pen-and-paper basis. The simulation follows the game-based learning principle so that the students experience the concept of the blockchain approach and its application.

Intended Learning Outcomes

By the end of this module, students will be able to

1. understand the technological aspects of Industry 4.0;
2. apply the IoT for enabling real-time interaction of production agents for adaptive planning
3. understand the transformative role of Industry 4.0 in manufacturing and logistics systems;
4. create architecture for enabling the collaboration of SMEs to form integrated supply chains
5. analyze and evaluate different production and manufacturing scenarios for adopting transformative changes.
6. evaluate the efficiency of transformed modern production and logistics system
7. create ideas for Cyber Physical System elaboration in different production and logistics businesses;
8. evaluate different practical IT reformed structures in manufacturing and production operations;
9. create the IT initiatives for enabling decentralized mechanisms in logistics and manufacturing system.
10. create smart based contract mechanisms for two to three tier supply chains.
11. evaluate the efficiency of Blockchain based traceability models in production and logistic model.
12. apply Blockchain capabilities for enabling the decentralized adaptive planning of logistics planning
13. explain the blockchain approach, including the basic concepts of cryptography and smart contracts;
14. discuss the challenges, advantages, and disadvantages of private and public blockchains;
15. analyze different consensus algorithms and demonstrate their advantages and disadvantages;
16. illustrate different applications of the blockchain approach in the field of Industrial engineering (e.g., production, logistics, and finance);
17. design and implement a blockchain simulation;

Indicative Literature

Drescher, D. (2017). Blockchain Basics: A Non-Technical Introduction in 25 Steps. Apress.

Hosp J. (2017). Cryptocurrencies Simply Explained. Julian Hosp Coaching LTD.

Narayanan, A., Bonneau, J., Felten, E. Miller, A., Goldfeder, S. (2016). Bitcoin and Cryptocurrency Technologies. Princeton University Press (Draft version: http://bitcoinbook.cs.princeton.edu/).

Sendler, U., Wawer V. (2008). CAD and PDM : Optimizing Proccesses by Integrating Them CAD und PDM, Hanser Verlag Muniche Vienna, ISBN: 978-3-446-41327-6 ; 3-446-41327-8.

Kale, V. (2016). Enhancing Enterprise Intelligence: Leveraging ERP, CRM, SCM, PLM, BPM, and BI, CRC Press.

Alp Ustundag, Emre Cevikcan, Industry 4.0.: Managing The Digital Transformation, Springer, 2017, ISBN 978-3-319-57870-5

Gronwald, K.-D. (2017). Integrated Business Information Systems A Holistic View of the Linked Business Process Chain ERP-SCM-CRM-BI-Big Data, Springer, ISBN 978-3-662-53291-1.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Project assessment (group assessment) Weight 100%
Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.14 Advanced Product Design

<table>
<tr><td colspan="3">Module Name

Advanced Product Design</td><td>Module Code

CA-S-IEM-802</td><td>Level (type)

Year 3
(Specialization)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP</td></tr>
<tr><td>CA-IEM-802</td><td colspan="3">Advanced Product Design</td><td>Lab</td><td>5.0</td></tr>
<tr><td>Module Coordinator

Dr. Stanislav Chankov</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory elective for IEM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills

☒ Product & Production System Design | ☒ None | 3D modelling software</td><td>Frequency

Annually

(Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lab (17.5 hours)
• Project Work (45 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Revise material on CAx systems and 3D modeling software.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module provides students with an overview of the technically oriented methodical advances in the engineering field. The focus will not only be on the purely theoretical transfer of knowledge, but theory will be presented in the context of practical examples and exercises to highlight the interaction between knowledge, creativity, and experience. The learned concepts shall be put into practice within the framework of “product development,” from the clarification of the requirements through to the development of the product, to manufacturing with a 3D printer. Three main focal points are covered in three sections. The first is methodical product development. This section will convey exemplary methods that will aid the goal-oriented development of a technical product. The second section will present the possibilities that modern CAx systems are offering as well as the potential of a thorough process chain within the product creation. The third section will focus on the various aspects of the construction procedure. This will entail a teamwork project, in which a product will be developed based on the given requirements and restrictions and then constructed using an open-source CAD system.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. explain and apply the "product development" framework: from clarification of the requirements, through development of the product, to actual manufacturing with a 3D printer;
2. apply math, science, and engineering standards to hands-on projects;
3. utilize designs for the development and production of a final project;
4. implement problem solving techniques based on specific scenarios;
5. develop an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, health and safety, manufacturability, and sustainability constraints;</td></tr>
</table>

6. develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Indicative Literature

Radhakrishnan, P.; Subramanian, S.; Raju, V. (2005). CAD/CAM/CIM , 3rd edition New age international (P), limited publishers.

Schaefer, D. (2014). Cloud-based Design and Manufacturing (CBDM): A Service-Oriented Product Development Paradigm for the 21st Century, Springer.

Nasr A. E.; Kamrani, A. K.; (2007). Computer-Based Design and Manufacturing: An Information-Based Approach, Springer.

Nasr, A. (2007). Computer-Based Design and Manufacturing An Information-Based Approach ,Springer, 2007.

Mitchell, F.H. (1991). CIM Systems: An Introduction to Computer-Integrated Manufacturing", Prentice Hall College Div; 1St Edition edition (January 1991), ISBN: 978-0131332997.

Benhabib, B. (2003). Manufacturing: Design, Production, Automation, and Integration, Marcel Dekker Inc.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Project assessment (group assessment) Weight: 100 %

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.15 Supply Chain Design

<table>
<tr><td colspan="3">Module Name

Supply Chain Design</td><td>Module Code

CA-S-IEM-803</td><td>Level (type)

Year 3 (Specialization)</td><td>CP

2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CA-IEM-803 | Supply Chain Design | Seminar | 2.5</td></tr>
<tr><td>Module Coordinator

Dr. Stanislav Chankov</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory elective for IEM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ General Logistics, Lean Supply Management
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: ☒ None</td><td>Frequency

Annually (Spring))

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Seminars (17.5 hours)
• Project Work (45 hours)

Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Revise material on Logistics and Supply Chain Management.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module will bundle theoretical methods for solving industrial problems in logistics networks with practical examples from industry. The tasks and goals of supply chain design, together with methods and instruments for the design of logistics networks, will be presented. Students work intensively in groups on several case studies and are thus able to apply the knowledge they have acquired in their modules and internships on real cases. At the end of the module, students write a paper in groups that investigates a specific supply chain-related problem that a company is facing. They also present the findings in group presentations.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. analyze real-world problems related to supply chain design;
2. design innovative solutions to existing problems by applying methods for the design of logistics networks on practical cases;
3. give a presentation on a given problem and derived solution and mange a project under time pressure (basic consulting skills).</td></tr>
<tr><td colspan="6">Indicative Literature

Watson, M. et al. (2012). Supply Chain Network Design: Understanding the Optimization Behind Supply Chain Design Projects. Aspen Blue Publishing.</td></tr>
<tr><td colspan="6">Usability and Relationship to other Modules</td></tr>
</table>

Examination Type: Module Examination

Assessment Type: Project assessment (group assessment) Weight: 100 %

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.16 Integrated Decision Making in Supply Chain Management

<table>
<tr><td colspan="3">Module Name

Integrated Decision Making in Supply Chain Management</td><td>Module Code

CA-S-IEM-804</td><td>Level (type)

Year 3 (Specialization)</td><td>CP

2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP</td></tr>
<tr><td>CA-IEM-804</td><td colspan="3">Integrated Decision Making in Supply Chain Management</td><td>Seminar</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Dr. Stanislav Chankov</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory elective for IEM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ General Logistics, Lean Supply Management
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: ☒ None</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Seminars (17.5 hours)
• Project Work (45 hours)

Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Familiarize yourself with the Fresh Connection game and the basics of fruit juice production and distribution.

Revise basic concepts from logistics and supply chain management.</td></tr>
<tr><td colspan="6">Content and Educational Aims

In this module, students play the Fresh Connection game, an innovative web-based business simulation that delivers the ultimate supply chain learning experience. It engages participants in making strategic decisions in the management of a fruit juice manufacturer. Working in teams of four, participants will represent the functional roles of sales, purchasing, supply chain, and operations. They will be confronted with various real-world, real-time dilemmas and render typical supply chain management decisions (e.g., supplier selection, production capacity planning, inventory management). Students learn how to use information in decision-making and how to handle risk and uncertainty, thus experiencing the power of true alignment and a well-articulated supply chain strategy, supported by tactical skills and knowledge.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. formulate and explain supply chain strategies;
2. make decisions in a high-pressure environment as part of a team considering conflicting logistics targets;
3. evaluate different suppliers and defend appropriate contract terms in a global supply chain environment;
4. design appropriate techniques for capacity planning in warehouses and production, inventory management, and demand forecasting;
5. analyze the environmental impact of a given supply chain and suggest sustainability improvements;
6. develop project management tools to effectively work in teams to perform a task.</td></tr>
</table>

Indicative Literature

Weenk, E. (2019). Mastering the Supply Chain: Principles, Practice and Real-Life Applications. Kogan Page.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Project assessment (group assessment)

Weight: 100 %

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.17 Distribution & E-commerce

<table>
<tr><td colspan="3">Module Name

Distribution & E-Commerce</td><td>Module Code

CA-S-IEM-805</td><td>Level (type)

Year 3 (Specialization)</td><td>CP

2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CA-IEM-805 | Distribution & E-Commerce | Lecture | 2.5</td></tr>
<tr><td>Module Coordinator

Dr. Stanislav Chankov</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory elective for IEM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
☒ Lean Supply Management | ☒ None | ☒ None</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lectures (17.5 hours)
• Project Work (45 hours)

Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Identify major e-commerce companies and read on their distribution strategies and processes.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module will introduce the concept of e-commerce and discuss its evolution as a business model and the challenges it brings for traditional distribution logistics. The module will consists of three main parts. The first part will outline the evolution of distribution logistics from direct to store deliveries in the early 1970s up to same-day deliveries and omnichannel supply chains developed by companies. The second part of the module is focused on new operational challenges imposed by e-commerce on the warehousing aspect of distribution logistics, namely the emergence of e-fulfillment centers and the increasing importance of parcel and sorting delivery centers. The last part of the module covers the concepts in last-mile delivery with a focus on different business models (e.g., Amazon, Zalando, Hello Fresh, Uber), the associated challenges for traditional transport, and distribution strategies and novel solution approaches.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. explain how new market trends shape traditional operations and distribution logistics;
2. describe and critically evaluate the evolution of e-commerce, its enablers, and new operational challenges in relation to distribution logistics;
3. evaluate the various challenges warehouses and sorting centers face in fulfilling e-commerce-specific requirements;
4. discuss the growing importance and complexity of last-mile deliveries and novel methods to tackle associated delivery problems;
5. apply theoretical models and frameworks from academic studies to analyze problems in practice;
6. match different types of operational problems with appropriate (technical) solution approaches;
7. critically evaluate and working through distribution and e-commerce case studies.</td></tr>
</table>

Indicative Literature

A collection of research articles, managerial publications and case studies will be used for this course. The materials will be made available to students two weeks before the beginning of the course.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Project assessment (group assessment) Weight: 100 %

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.18 Law of Transportation, Forwarding and Logistics

<table>
<tr><td colspan="3">Module Name

Law of Transportation, Forwarding and Logistics</td><td>Module Code

CA-S-IEM-806</td><td>Level (type)

Year 3 (Specialization)</td><td>CP

2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CA-IEM-806 | Law of Transportation, Forwarding and Logistics | Lecture | 2.5</td></tr>
<tr><td>Module Coordinator

Dr. Stanislav Chankov</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory elective for IEM</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
☒ Lean Supply Management | ☒ None | ☒ None</td><td>Frequency

Annually (Spring)</td><td colspan="2">Forms of Learning and Teaching

• Lectures (17.5 hours)
• Private Study (45 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Familiarize yourself with basic terms of German labor law and international trade law.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module deals with the legal aspects of transportation, forwarding, and logistics. After an outline of several aspects of international and national trade law, including the formation of contracts, incorporation of general conditions, and the law of sales contracts, the module focuses on national law on transportation, logistics, and freight forwarding. Thereafter, international conventions on the carriage of goods by sea, air, and land—including multimodal carriage—will be covered. Since logistics is a manifold area, the students will be introduced to the law of warehousing, product assembly, and the handling of dangerous goods in an international context. Focus is placed on the law of other contracts related to transportation and logistics: insurance (marine and liability insurance), agency, construction and long-term contracts, and product liability. The module will end with an outline of international private law (conflicts of law), jurisdiction, litigation, and arbitration.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. discuss international trade law in the context of logistics and transportation and international private law;
2. evaluate contracts for transportation, forwarding and logistics activities;
3. explain international conventions for the carriage of goods;
4. analyze legal aspects in contract negotiations for logistics or related contracts.</td></tr>
<tr><td colspan="6">Indicative Literature

David, P. (2003). International Logistics. Dreamtech Press.</td></tr>
</table>

Jané, J. and de Ochoa, A. (2006). The Handbook of Logistics Contracts: A Practical Guide to a Growing Field. Palgrave Macmillan UK.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination

Duration: 90 minutes.
Weight: 100 %

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.19 Machine Learning

<table>
<tr><td colspan="3">Module Name

Machine Learning</td><td>Module Code

CO-541</td><td>Level (type)

Year 3
(Specialisation)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CO-541-A | Machine Learning | Lecture | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Francesco Maurelli</td><td colspan="3">Program Affiliation

• Robotics and Intelligent Systems (RIS)</td><td colspan="2">Mandatory Status

Mandatory for DSSD, MMDA, PHDS, RIS and minor RIS

Mandatory elective for CS</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒None
Knowledge, Abilities, or Skills:
• Knowledge and command of probability theory and methods, as in the module “Probability and Random Process (JTMS-12)</td><td>Frequency

Annually

(Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Class attendance (35 hours)
• Private study (70 hours)
• Exam preparation (20 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

None</td></tr>
<tr><td colspan="6">Content and Educational Aims

Machine learning (ML) concerns algorithms that are fed with (large quantities of) real-world data, and which return a compressed “model” of the data. An example is the “world model” of a robot; the input data are sensor data streams, from which the robot learns a model of its environment, which is needed, for instance, for navigation. Another example is a spoken language model; the input data are speech recordings, from which ML methods build a model of spoken English; this is useful, for instance, in automated speech recognition systems. There exist many formalisms in which such models can be cast, and an equally large diversity of learning algorithms. However, there is a relatively small number of fundamental challenges that are common to all of these formalisms and algorithms. The lectures introduce such fundamental concepts and illustrate them with a choice of elementary model formalisms (linear classifiers and regressors, radial basis function networks, clustering, online adaptive filters, neural networks, or hidden Markov models). Furthermore, the lectures also (re-)introduce required mathematical material from probability theory and linear algebra.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students should be able to

1. understand the notion of probability spaces and random variables;
2. understand basic linear modeling and estimation techniques;
3. understand the fundamental nature of the “curse of dimensionality;”
4. understand the fundamental nature of the bias-variance problem and standard coping strategies;
5. use elementary classification learning methods (linear discrimination, radial basis function networks, multilayer perceptrons);
6. implement an end-to-end learning suite, including feature extraction and objective function optimization with regularization based on cross-validation.

Indicative Literature

T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd edition, Springer, 2008.

S. Shalev-Shwartz, Shai Ben-David: Understanding Machine Learning, Cambridge University Press, 2014.

C. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

T.M. Mitchell, Machine Learning, Mc Graw Hill India, 2017.

Usability and Relationship to other Modules

- This module gives a thorough introduction to the basics of machine learning. It complements the Artificial Intelligence module.

Examination Type: Module Examination

Assessment Type: Written examination — Duration: 120 min
Weight: 100%

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%.

7.20 Guided Industrial Project / Mandatory Internship

<table>
<tr><td colspan="3">Module Name

Guided Industrial Project / Mandatory Internship</td><td>Module Code

CA-INT-901</td><td>Level (type)

Year 3
(Internship)</td><td>CP

30</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CA-901-0 | Internship IEM | Internship | 30</td></tr>
<tr><td>Module Coordinator

Sinah Vogel &
Dr. Tanja Woebs (CSC Organization);
SPC / Faculty Startup Coordinator (Academic responsibility);</td><td colspan="3">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory for IEM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ At least 15 CP from IEM CORE modules
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• Information provided on CSC pages (see below)
• Major specific knowledge and skills</td><td>Frequency

Annually
(Fall)</td><td colspan="2">Forms of Learning and Teaching

• Internship/Start-up
• Internship event
• Seminars, info-sessions, workshops and career events
• Self-study, readings, online tutorials
• IEM internship preparation workshops</td></tr>
<tr><td colspan="3"></td><td>Duration
1 semester</td><td colspan="2">Workload

750 Hours consisting of:
• Internship (616 hours)
• Workshops (20 hours)
• Internship event (2 hours)
• Self-study (112 hours)</td></tr>
<tr><td colspan="6">Recommendations for Preparation

• Reading the information in the menu sections “Internship Information”, “Career Events”, “Create Your Application” and “Seminars & Workshops” at the Career Service Center (CSC) website http://csc-microsite.user.jacobs-university.de/
• Completing all four online tutorials about job market preparation and the application process (http://csc-microsite.user.jacobs-university.de/create-your-application/tutorials/)
• Participation in the Internship Events of earlier classes</td></tr>
<tr><td colspan="6">Content and Educational Aims

The aims of the internship module are reflection, application, orientation, and development. Students can reflect on their interests, knowledge, skills, their role in society, the relevance of their major subject in society; apply these skills and knowledge in real life while obtaining practical experience; find their professional orientation; and develop their personality</td></tr>
</table>

and career. The module supports the programs' aims of preparing students for gainful, qualified employment and the development of their personality.

The full-time internship must be related to industrial engineering and management and extends over a minimum period of four consecutive months, normally scheduled in the fifth semester, with the internship event and submission of the internship report in the sixth semester. The Study Program Coordinator or their faculty delegate approves the intended internship by reviewing the tasks in either the Internship Contract or Internship Confirmation from the respective internship institution or company. Further regulations as set out in the Policies for Bachelor Studies apply.

The internship will be gradually prepared in semesters 1 to 4 by a series of mandatory information sessions, seminars, and career events.
The internship will be gradually prepared in semesters 1 to 4 by a series of mandatory information sessions, seminars and career events.
The purpose of the Career Services Information Sessions is to provide all students with basic facts about the job market in general and especially in Germany and the EU, and services provided by the Student Career Support (SCS).
In the Career Skills Seminars, students will learn how to engage in the internship/job search, how to create a competitive application (CV, Cover Letter etc.) and how to successfully conduct job interviews and/or assessment centers. In addition to this mandatory part, students can customize their set of skills regarding the application challenges and intended career path in elective seminars.
Finally, during the Career Events organized by the Student Career Support (SCS)(e.g., the annual Constructor University Career Fair and single employer events on and off campus), students will have the opportunity to apply their acquired job market skills in an actual internship/job search situation and gain a desired internship in a high-quality environment and with excellent employers

In the IEM specialized internship workshops in semesters 1-4, students receive further guidance on how to apply for specific internship positions in the industry.

As an alternative to the full-time internship, students can apply for the StartUp-Option with 15 CP to reduce the full-time internship to 8 weeks (15 CP). Following the same schedule as the full-time internship, the StartUp Option allows students who are interested in founding their own company to focus on the development of their business plan over a period of two consecutive months. Participation in the StartUp Option depends on a successful presentation of the initial Startup idea. This presentation will be held at the beginning of the fourth semester. A jury of faculty members will judge the potential to realize the idea and approve the participation of the students. The StartUp Option is supervised by the Faculty StartUp Coordinator. At the end of the StartUp Option, students submit their business plan. Further regulations as set out in the Policies for Bachelor Studies apply.

The concluding IEM Internship Event will formally conclude the module by providing students the opportunity to present their internships (on posters) and reflect on the lessons learned. The purpose is not only to self-reflect on the whole process but also to create a professional network within the academic community, especially byentering the Alumni Network after graduation. It is recommended that all three classes of the same major are present at this event to enable the creation of networks between older and younger students and to create a learning environment for younger students in the sense of a "lessons learned" effect from the diverse internships of their elder fellow students.

Finally, students are required to examine the economic, social and environmental impacts as well as the ethical implications of the processes within their department or company. Moreover, they are also strongly encouraged to trigger an awareness campaign or to suggest a change to a process in their department or company leading to higher sustainability and/or corporate social responsibility. The main relevant findings and students' reflections are to be included in the internship report and the poster presentation. Thus, the internship module intends to raise awareness of the global challenges of the future and broaden the students' horizon with applied problem solving beyond the borders of their own discipline, preparing them to become informed and responsible citizens in a global society.

Intended Learning Outcomes

By the end of this module, students should be able to

1. critically analyze industrial problems in a real-world environment;
2. create solutions to real industrial situations applying principles of industrial engineering, business administration, strategy, logistics and supply chain management;
3. professionally communicate their conclusions and recommendations in both spoken and written form;
4. describe the scope and the functions of the employment market and personal career development;
5. apply professional, personal, and career-related skills for the modern labor market, including self-organization, initiative and responsibility, communication, intercultural sensitivity, and team and leadership skills;
6. independently manage their own career orientation processes: identify personal interests, select appropriate internship destinations or start-up opportunities, conduct interviews, pitches or assessment centers, negotiate related employment, funding or support conditions (such as salary, contract, funding, supplies, work space);
7. apply specialist skills and knowledge acquired during their studies to solve problems in a professional environment and reflect on their relevance in employment and society;
8. justify professional decisions based on theoretical knowledge and academic methods;
9. reflect on their professional conduct in the context of expectations by and consequences for employers and society;
10. reflect on and set targets for further development of their knowledge, skills, interests and values;
11. establish and expand contacts with potential employers, business partners, and other students and alumni to build their own professional network to create employment opportunities in the future;
12. discuss observations and reflections in a professional network;
13. critically analyze the economic, social, and environmental impacts as well as the ethical implications of real-world industrial processes with regard to sustainability and corporate social responsibility.

Indicative Literature

Not specified

Usability and Relationship to other Modules

- This module applies skills and knowledge acquired in previous modules to a professional environment and provides an opportunity to reflect on their relevance in employment and society. It may lead to Thesis topics.

Examination Type: Module Examination

Assessment type 1: Project report — Length: approx. 3,500 words
Scope: All intended learning outcomes

Assessment type 2: Poster presentation — Duration: 10-15 minutes
Scope: All intended learning outcomes

Two separate assessments are justified by the size of the module and the fact that the justification of solutions to problems and arguments (ILO 6) and discussion (ILO 7) should at least have verbal elements. The weights of the assessments are commensurate with the sizes of the respective module components.

Completion: This module is passed with an assessment-component weighted average grade of 45% or higher.

7.21 Bachelor Thesis and Seminar IEM

<table>
<tr><td colspan="3">Module Name

Bachelor Thesis and Seminar IEM</td><td>Module Code

CA-IEM-800</td><td>Level (type)

Year 3 (CAREER)</td><td>CP

15</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CA-IEM-800-T | Thesis IEM | Thesis | 12
CA-IEM-800-S | Thesis Seminar IEM | Seminar | 3</td></tr>
<tr><td colspan="2">Module Coordinator

Study Program Chair</td><td colspan="2">Program Affiliation

• Industrial Engineering & Management (IEM)</td><td colspan="2">Mandatory Status

Mandatory for IEM</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites

☒ Students must have taken and successfully passed a total of at least 30 CP from advanced modules, and of those, at least 20 CP from advanced modules in the major

Co-requisites

☒ None

Knowledge, Abilities, or Skills

• Comprehensive knowledge of the subject and deeper insight into the chosen topic;
• ability to plan and undertake work independently;
• skills needed to identify and critically review literature.</td><td>Frequency

Annually (Spring)</td><td colspan="2">Forms of Learning and Teaching

• Self-study/lab work (350 hours)
• Seminars (25 hours)</td></tr>
<tr><td>Duration

14-Weeks lecture period</td><td colspan="2">Workload

375 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

• Identify an area or a topic of interest and discuss this with your prospective supervisor in a timely manner.
• Create a research proposal including a research plan to ensure timely submission.
• Ensure you possess all required technical research skills or are able to acquire them on time.
• Review the University’s Code of Academic Integrity and Guidelines to Ensure Good Academic Practice.</td></tr>
</table>

Content and Educational Aims

This module is a mandatory graduation requirement for all undergraduate students. It demonstrates their ability to deal with a problem from their respective major subject independently using academic/scientific methods within a set period. Although supervised, the module requires students to be able to work independently and regularly and set their own goals in exchange for the opportunity to explore a topic that excites and interests them and which a faculty member is interested in supervising. Within this module, students apply their acquired knowledge about the major discipline, skills, and methods for conducting research, including the identification of suitable (short-term) research projects; preparatory literature searches; the realization of discipline-specific research; and the documentation, discussion, interpretation and communication of the results.

This module consists of two components, an independent thesis and an accompanying seminar. The thesis component must be supervised by a Constructor University faculty member and requires short-term research work, the results of which must be documented in a comprehensive written thesis, including an introduction, a justification of the methods, results, a discussion of the results, and conclusions. The seminar provides students with the opportunity to present, discuss, and justify their and other students' approaches, methods, and results at various stages of their research in order to practice these skills and improve their academic writing and receive and reflect on formative feedback, thereby growing personally and professionally.

Intended Learning Outcomes

On completion of this module, students will be able to

1. independently plan and organize advanced learning processes;
2. design and implement appropriate research methods taking full account of the range of alternative techniques and approaches;
3. collect, assess and interpret relevant information;
4. draw scientifically founded conclusions that consider social, scientific and ethical insights;
5. apply their knowledge and understanding to a context of their choice;
6. develop, formulate and advance solutions to problems and arguments in their subject area, and defend these through argument;
7. discuss information, ideas, problems and solutions with specialists and non-specialists.

Usability and Relationship to other Modules

- This module builds on all previous modules of the program. Students apply the knowledge, skills and competencies they acquired and practiced during their studies, including research methods and the ability to acquire additional skills independently as and if required.

Examination Type: Module Component Examinations

Module Component 1: Thesis
Assessment type: Thesis
Scope: All intended learning outcomes, mainly 1-6.
Weight: 80%
Length: approx. 6.000 – 8.000 words (25 –35 pages), excluding front- and back matter.

Module Component 2: Seminar
Assessment type: Presentation
Duration: approx. 15 to 30 minutes
Weight: 20%

Scope: The presentation focuses mainly on ILOs 6 and 7, but by nature of these ILOs it also touches on the others.

Completion: To pass this module, the examination of each module component has to be passed with at least 45%

Two separate assessments are justified by the size of this module and the fact that the justification of solutions to problems and arguments (ILO 6) and discussion (ILO 7) should at least have verbal elements. The weights of the types of assessments are commensurate with the sizes of the respective module components.

8 CONSTRUCTOR Track Modules

8.1 Methods Modules

8.1.1 Applied Calculus

<table>
<tr><td colspan="3">Module Name
Applied Calculus</td><td>Module Code
CTMS-MAT-08</td><td>Level (type)
Year 1 (Methods)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td colspan="2">Type</td></tr>
<tr><td>CTMS-08</td><td colspan="3">Applied Calculus</td><td colspan="2">Lecture (in presence / online)
5</td></tr>
<tr><td colspan="2">Module Coordinator
NN</td><td colspan="3">Program Affiliation
• CONSTRUCTOR Track Area</td><td>Mandatory Status
Mandatory for GEM, IBA, IEM and MDDA</td></tr>
<tr><td colspan="3">Entry Requirements
Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• Knowledge of Mathematics at high school level (Functions, graphs of functions, linear and polynomial functions, logarithms and exponential function, basic trigonometric functions, elementary methods for solving systems of linear and nonlinear equations)
• Some familiarity with elementary calculus (limits, derivatives) is helpful, but not required.</td><td>Frequency
Annually (Fall)
Duration
1 semester</td><td colspan="2">Forms of Learning and Teaching
• Lectures (35 hours)
• Private study (90 hours)
Workload
125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
None.</td></tr>
<tr><td colspan="6">Content and Educational Aims
This module is an introduction to Calculus for students in life sciences, applied engineering, humanities and social science majors. It gives a broad overview of the methods of Calculus, putting more emphasis on applications, rather than on mathematical rigor. Most of the concepts and methods are backed up by examples from chemistry, biology, economics and/or other sciences. In this module students enhance both their quantitative problem-solving skills as well as their conceptual understanding of mathematical methods.

The lecture comprises the following topics:
• Brief review of elementary functions and their graphs
• Intuitive understanding of limits; horizontal and vertical asymptotes
• Derivatives and their computation</td></tr>
</table>

- Applications of derivatives (interpretation of derivatives, their units, local linear approximation, error propagation, optimization problems)
- Brief introduction to functions of several variables, partial derivatives, local minima and maxima
- Integrals and their computation
- Applications of integrals (accumulated change, average value, applications in probability: density functions and cumulative distribution functions)
- Brief introduction to differential equations.

Intended Learning Outcomes

By the end of the module, students will be able to

1. apply the fundamental concepts of Calculus in structured situations;
2. command the methods described in the content section of this module description to the extent that they can solve standard text-book problems reliably and with confidence;
3. explain importance of the methods of Calculus in problems arising from applications;
4. understand the methods of Calculus, used in other modules, as well as in scientific literature.

Indicative Literature

D. Hughes-Hallett, A. Gleason, P. Lock, D. Flath, et al. (2010/2013). Applied Calculus, 4th or 5th edition. Hoboken: Wiley.

Usability and Relationship to other Modules

- The module serves as preparation for the 2nd year IEM CORE module Operations Research.
- This serves as preparation for the 1st year GEM and IBA modules Microeconomics, Macroeconomics and Introduction to Finance and Accounting
- A mathematically rigorous treatment of Calculus is provided in the module “Analysis I”.
- The first year modules Calculus and Elements of Linear Algebra I+II can be used in place of the modules Applied Calculus and Finite Mathematics, respectively, to satisfy the graduation requirements in majors in which they are mandatory.

Examination Type: Module Examination

Assessment type: Written examination — Duration: 120 min
Weight: 100%

Scope: All intended learning outcomes of this module

Completion: To pass this module, the examination has to be passed with at least 45%.

8.1.2 Finite Mathematics

<table>
<tr><td colspan="2">Module Name

Finite Mathematics</td><td>Module Code

CTMS-MAT-11</td><td>Level (type)

Year 1 (Methods)</td><td>CP

5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP
CTMS-11 | Finite Mathematics | Lecture (in presence / online) | 5</td></tr>
<tr><td>Module Coordinator

NN</td><td colspan="2">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory for IEM</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites: ☒None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• The topics in this module are elementary, yet some command of mathematical language is required at a level that corresponds to an upper-level high-school education in mathematics and/or the Constructor University first-semester modules Mathematical Concepts in the Sciences, Applied Calculus, or Calculus and Elements of Linear Algebra I.</td><td>Frequency

Annually

(Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lectures (35 hours)
• Private study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

Review -the following topics at high school or elementary university level:
• Elementary solution strategies for systems of linear equations
• Solution of quadratic equations
• Factorization of polynomials
• Equations of lines
• Elementary notions of probability</td></tr>
<tr><td colspan="5">Content and Educational Aims

This module is the second semester in a sequence of mathematical methods modules for students in the sciences, industrial engineering, and management majors It aims at rounding off the mathematical education for students in these majors with topics from matrix algebra, probability, and related subjects in a way that is directly useful for the applications in experimental sciences, economics, management, and applied engineering.

The lecture comprises the following topics
• Graphs of lines and planes
• Linear regression and applications
• Systems of linear equations and applications
• Matrix formulation of linear equations, matrix algebra
• Gauss elimination, inverse matrices
• Linear inequalities
• Markov chain
• Sets, counting principles, permutations, combinations</td></tr>
</table>

- Sample space, event, probability
- Conditional probability, independence, Bayes' rule with applications
- Expected value, variance, standard deviation
- Binomial distribution and normal distribution
- Elementary descriptive statistics

Intended Learning Outcomes

By the end of the module, students will be able to

1. apply the methods described in the content section of this module description to the extent that they can solve standard text-book problems reliably and with confidence;
2. recognize the mathematical structures in an unfamiliar context and translate them into a mathematical problem statement;
3. recognize common mathematical terminology used in textbooks and research papers in science; economics, business, and applied engineering to the extent that they are covered by the content of this module.

Indicative Literature

M.L. Lial, R.N. Greenwell, N.P. Ritchey (2015). Finite Mathematics, 11th edition. London: Pearson.

S. Shores (2007). Applied Linear Algebra and Matrix Analysis. Berlin: Springer.

Usability and Relationship to other Modules

- This module serves as a preparation for the 2nd year IEM CORE module Operations Research.
- This module is accessible to all Constructor University students with a minimum of mathematical pre-knowledge and covers a broad range of non-calculus applications of mathematics across a broad spectrum of fields of study
- It most naturally complements the module Applied Calculus which covers elementary calculus-based applications of mathematics in a similar spectrum of fields
- There is no strict dependence between Applied Calculus and Finite Mathematics, but the default recommendation is to take Applied Calculus in the first semester and Finite Mathematics in the second semester
- Students in majors that require a more advanced mathematics and methods education should consult their program handbooks
- The first year modules Calculus and Elements of Linear Algebra I+II can be used in place of the modules Applied Calculus and Finite Mathematics, respectively, to satisfy the graduation requirements in majors in which they are mandatory.

Examination Type: Module Examination

Assessment type: Written examination Duration: 120 min

Weight: 100%

Scope: All intended learning outcomes of this module

Completion: To pass this module, the examination has to be passed with at least 45%.

8.1.3 Programming in Python

<table>
<tr><td colspan="2">Module Name

Programming in Python</td><td>Module Code

CTMS-SKI-14</td><td>Level (type)

Year 2 (Methods)</td><td>CP

5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP
CTMS-14 | Programming in Python | Lecture | 5</td></tr>
<tr><td>Module Coordinator

Dr. Kinga Lipskoch</td><td colspan="2">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory for IEM</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites

☒ None

Co-requisites

☒ None

Knowledge, Abilities, or Skillsnone</td><td>Frequency

Annually

(Fall)</td><td colspan="2">Forms of Learning and Teaching

• Class attendance (35 hours)
• Private study (85 hours)
• Exam preparation (5 hours)</td></tr>
<tr><td colspan="2"></td><td>Duration

1 semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

It is recommended that students install a suitable programming environment (simple editor or Integrated Development Environment) and a new stable version of Python on their notebooks.</td></tr>
<tr><td colspan="5">Content and Educational Aims

This module offers an introduction to programming using the programming language Python. The module presents the basics of Python programming and provides a short overview of the program development cycle. It covers fundamental programming components and constructs in a hands-on manner. The beginning of the module covers the concepts of data types, variables, operators, strings and basic data structures. Next, other programming constructs such as branching, iterations, and data structures such as strings, lists, tuples, and dictionaries are introduced. The module also gives an introduction to functions, as well as simple file handling by introducing reading data from files, processing the data and writing the results to files. Later, object-oriented programming concepts such as constructors, methods, overloaded operators and inheritance are presented. Retrieving data from URLs and processing of larger amounts of data and their queries and storage in files are addressed. Simple interactive graphics and operations are also presented with the help of an object-oriented graphics library.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. explain basic concepts of imperative programming languages such as variables, assignments, loops, function calls, data structures;
2. work with user input from the keyboard, and write interactive Python programs;
3. write, test, and debug programs;
4. illustrate basic object-oriented programming concepts such as objects, classes, information hiding, and inheritance;
5. give original examples of function and operator overloading;
6. retrieve data and process and generate data from/to files;
7. use some available Python modules and libraries such as those related to data or graphics.

Indicative Literature

Kenneth A. Lambert (2014). Fundamentals of Python Data Structures. Boston: Cengage Learning PTR.

Mark Summerfield (2010). Programming in Python: A complete introduction to the Python language, second edition. London: Pearson Education.

John Zelle (2009). Python Programming: An introduction to Computer Science, second edition. Portland: Franklin, Beedle & Associates.

Igor Milovanovic (2013). Python Data Visualization Cookbook. Birmingham: Packt Publishing.

Cay Horsmann, Rance D. Necaise (2014). Python for Everyone. Hoboken: Wiley.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment type: Written examination Duration 120 min
Weight: 100%

Scope: All intended learning outcomes of the module
Module achievements: 50% of the assignments passed

Completion: To pass this module, the examination must be passed with at least 45%.

8.1.4 Applied Statistics with R

<table>
<tr><td colspan="2">Module Name

Applied Statistics with R</td><td>Module Code

CTMS-MET-03</td><td colspan="2">Level (type)

Year 1 (Methods)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CTMS-03 | Applied Statistics with R | Lecture & Lab | 5</td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr. Adalbert F.X. Wilhelm</td><td colspan="2">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory for ESSMER, GEM, IEM, ISCP and MDDAMandatory elective for IBA and , IRPH</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites

☒ None

Co-requisites

☒ None

Knowledge, Abilities, or Skills
• none</td><td>Frequency

Annually

(Spring)</td><td colspan="2">Forms of Learning and Teaching

• Lecture (17.5 hours)
• Lab (17.5 hours)
• Homework and self-study (90 hours)</td></tr>
<tr><td colspan="3"></td><td>Duration

1 semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
Get acquainted to statistical thinking by watching online videos for introductory probability and statistics as well as paying attention whenever arguments are backed up by empirical data.</td></tr>
<tr><td colspan="6">Content and Educational Aims

We live in a world full of data and more and more decisions are taken based on a comprehensive analysis of data. A central method of data analysis is the use of models describing the relationship between a set of predictor variables and a response. This module provides a thorough introduction to quantitative data analysis covering graphical representations, numerical summary statistics, correlation, and regression models. The module also introduces the fundamental concepts of statistical inference. Students learn about the different data types, how to best visualize them and how to draw conclusions from the graphical representations. Students will learn in this module the ideas and techniques of regression models within the generalized linear model framework involving multiple predictors and co-variates. Students will learn how to become an intelligent user of statistical techniques from a prosumers perspective to assess the quality of presented statistical results and to produce high-quality analyses by themselves. By using illustrative examples from economics, engineering, and the natural and social sciences students will gain the relevant background knowledge for their specific major as well as an interdisciplinary glimpse of other research fields. The general objective of the module is to enable students to become skilled statistical modelers who are well versed in the various assumptions, limitations, and controversies of statistical models and their application. Regular exercises and practical sessions will corroborate the students' proficiency with the statistical software R.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. apply basic techniques in statistical modeling and quantitative research methods
2. describe fundamental statistical concepts, procedures, their assumptions and statistical fallacies
3. explain the potential of using quantitative methods in all fields of applications;
4. express informed skepticism of the limitations of statistical reasoning;
5. interpret statistical modeling results in scientific publications;
6. perform basic and intermediate-level statistical analyses of data, using R.

Indicative Literature

Michael J. Crawley (2013). The R Book, Second Edition. Hoboken: John Wiley & Sons.

Peter Daalgard (2008). Introductory Statistics with R. Berlin: Springer.

John Maindonald, W. John Braun (2010). Data Analysis and Graphics Using R – an Example-Based Approach, Third Edition, Cambridge Series. In Statistical and Probabilistic Mathematics. Cambridge: Cambridge University Press.

Christopher Gandrud (2015). Reproducible Research with R and RStudio, Second Edition. The R Series, Chapman & Hall/CRC Press.

Randall E. Schumacker (2014). Learning Statistics Using R. Thousand Oaks: Sage.

Charles Wheelan (2013). Naked Statistics: Stripping the Dread from The Data. New York: W.W. Norton & Company.

Usability and Relationship to other Modules

- Quantitative analytical skills are used and needed in many modules of all study programs.
- This module introduces students to R in preparation for the 2nd year mandatory method module on econometrics and 3rd year GEM module on advanced econometrics; the statistics skills prepare students for all 2nd and 3rd year GEM modules and the thesis.

Examination Type: Module Examination

Assessment Type: Written examination Duration: 120 min
Weight: 100%

During the examination students use the software R as an auxiliary resource approved by the Instructor of Record.

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination must be passed with at least 45%.

8.2 New Skills

8.2.1 Logic (perspective I)

<table>
<tr><td colspan="3">Module Name
Logic (perspective I)</td><td>Module Code
CTNS-NSK-01</td><td>Level (type)
Year 2
(New Skills)</td><td>CP
2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CTNS-01 | Logic (perspective I) | Lecture (online) | 2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Jules Coleman</td><td colspan="3">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory elective for all UG students (one perspective must be chosen)</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills</td><td>Frequency

Annually
(Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

Online lecture (17.5h)
Private study (45h)

Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation</td></tr>
<tr><td colspan="6">Content and Educational Aims

Suppose a friend asks you to help solve a complicated problem? Where do you begin? Arguably, the first and most difficult task you face is to figure out what the heart of the problem actually is. In doing that you will look for structural similarities between the problem posed and other problems that arise in different fields that others may have addressed successfully. Those similarities may point you to a pathway for resolving the problem you have been asked to solve. But it is not enough to look for structural similarities. Sometimes relying on similarities may even be misleading. Once you've settled tentatively on what you take to be the heart of the matter, you will naturally look for materials, whether evidence or arguments, that you believe is relevant to its potential solution. But the evidence you investigate of course depends on your formulation of the problem, and your formulation of the problem likely depends on the tools you have available – including potential sources of evidence and argumentation. You cannot ignore this interactivity, but you can't allow yourself to be hamstrung entirely by it. But there is more. The problem itself may be too big to be manageable all at once, so you will have to explore whether it can be broken into manageable parts and if the information you have bears on all or only some of those parts. And later you will face the problem of whether the solutions to the particular sub problems can be put together coherently to solve the entire problem taken as a whole.

What you are doing is what we call engaging in computational thinking. There are several elements of computational thinking illustrated above. These include: Decomposition (breaking the larger problem down into smaller ones); Pattern recognition (identifying structural similarities); Abstraction (ignoring irrelevant particulars of the problem): and Creating Algorithms), problem-solving formulas.

But even more basic to what you are doing is the process of drawing inferences from the material you have. After all, how else are you going to create a problem-solving formula, if you draw incorrect inferences about what information has shown and what, if anything follows logically from it. What you must do is apply the rules of logic to the information to draw inferences that are warranted.

We distinguish between informal and formal systems of logic, both of which are designed to indicate fallacies as well as warranted inferences. If I argue for a conclusion by appealing to my physical ability to coerce you, I prove nothing about the</td></tr>
</table>

truth of what I claim. If anything, by doing so I display my lack of confidence in my argument. Or if the best I can do is berate you for your skepticism, I have done little more than offer an ad hominem instead of an argument. Our focus will be on formal systems of logic, since they are at the heart of both scientific argumentation and computer developed algorithms. There are in fact many different kinds of logic and all figure to varying degrees in scientific inquiry. There are inductive types of logic, which purport to formalize the relationship between premises that if true offer evidence on behalf of a conclusion and the conclusion and are represented as claims about the extent to which the conclusion is confirmed by the premises. There are deductive types of logic, which introduce a different relationship between premise and conclusion. These variations of logic consist in rules that if followed entail that if the premises are true then the conclusion too must be true.

There are also modal types of logic which are applied specifically to the concepts of necessity and possibility, and thus to the relationship among sentences that include either or both those terms. And there is also what are called deontic logic, a modification of logic that purport to show that there are rules of inference that allow us to infer what we ought to do from facts about the circumstances in which we find ourselves. In the natural and social sciences most of the emphasis has been placed on inductive logic, whereas in math it is placed on deductive logic, and in modern physics there is an increasing interest in the concepts of possibility and necessity and thus in modal logic. The humanities, especially normative discussions in philosophy and literature are the province of deontic logic.

This module will also take students through the central aspects of computational thinking, as it is related to logic; it will introduce the central concepts in each, their relationship to one another and begin to provide the conceptual apparatus and practical skills for scientific inquiry and research.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to:

1. apply the various principles of logic and expand them to computational thinking.
2. understand the way in which logical processes in humans and in computers are similar and different at the same time.
3. apply the basic rules of first-order deductive logic and employ them rules in the context of creating a scientific or social scientific study and argument.
4. employ those rules in the context of creating a scientific or social scientific study and argument.

Indicative Literature

Frege, Gottlob (1879), Begriffsschrift, eine der arithmetischen nachgebildete Formelsprache des reinen Denkens [Translation: A Formal Language for Pure Thought Modeled on that of Arithmetic],Halle an der Salle: Verlag von Louis Nebert.

Gödel, Kurt (1986), Russels mathematische Logik. In: Alfred North Whitehead, Bertrand Russell: Principia Mathematica. Vorwort, S. V–XXXIV. Suhrkamp.

Leeds, Stephen. "George Boolos and Richard Jeffrey. Computability and logic. Cambridge University Press, New York and London1974, x+ 262 pp." The Journal of Symbolic Logic 42.4 (1977): 585-586.

Kubica, Jeremy. Computational fairy tales. Jeremy Kubica, 2012.

McCarthy, Timothy. "Richard Jeffrey. Formal logic: Its scope and limits. of XXXVIII 646. McGraw-Hill Book Company, New York etc. 1981, xvi+ 198 pp." The Journal of Symbolic Logic 49.4 (1984): 1408-1409.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written Examination — Duration: 60 min
Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%

8.2.2 Logic (perspective II)

<table>
<tr><td colspan="3">Module Name
Logic (perspective II)</td><td>Module Code
CTNS-NSK-02</td><td>Level (type)
Year 2
(New Skills)</td><td>CP
2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CTNS-02 | Logic (perspective II) | Lecture (online) | 2.5</td></tr>
<tr><td>Module Coordinator

NN</td><td colspan="3">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory elective for all UG students (one perspective must be chosen)</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
☒ none | ☒ none</td><td>Frequency

Annually (Fall)</td><td colspan="2">Forms of Learning and Teaching

Online lecture (17.5h)
Private study (45h)</td></tr>
<tr><td colspan="3"></td><td>Duration

1 semester</td><td colspan="2">Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation</td></tr>
<tr><td colspan="6">Content and Educational Aims

The focus of this module is on formal systems of logic, since they are at the heart of both scientific argumentation and computer developed algorithms. There are in fact many kinds of logic and all figure to varying degrees in scientific inquiry. There are inductive types of logic, which purport to formalize the relationship between premises that if true offer evidence on behalf of a conclusion and the conclusion and are represented as claims about the extent to which the conclusion is confirmed by the premises. There are deductive types of logic, which introduce a different relationship between premise and conclusion. These variations of logic consist in rules that if followed entail that if the premises are true then the conclusion too must be true.

This module introduces logics that go beyond traditional deductive propositional logic and predicate logic and as such it is aimed at students who are already familiar with basics of traditional formal logic. The aim of the module is to provide an overview of alternative logics and to develop a sensitivity that there are many different logics that can provide effective tools for solving problems in specific application domains.

The module first reviews the principles of a traditional logic and then introduces many-valued logics that distinguish more than two truth values, for example true, false, and unknown. Fuzzy logic extends traditional logic by replacing truth values with real numbers in the range 0 to 1 that are expressing how strong the believe into a proposition is. Modal logics introduce modal operators expressing whether a proposition is necessary or possible. Temporal logics deal with propositions that are qualified by time. Once can view temporal logics as a form of modal logics where propositions are qualified by time constraints. Interval temporal logic provides a way to reason about time intervals in which propositions are true.

The module will also investigate the application of logic frameworks to specific classes of problems. For example, a special subset of predicate logic, based on so-called Horn clauses, forms the basis of logic programming languages such as Prolog. Description logics, which are usually decidable logics, are used to model relationships and they have applications in the semantic web, which enables search engines to reason about resources present on the Internet.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to:

1. apply the various principles of logic
2. explain practical relevance of non-standard logic
3. describe how many-valued logic extends basic predicate logic
4. apply basic rules of fuzzy logic to calculate partial truth values</td></tr>
</table>

5. sketch basic rules of temporal logic
6. implement predicates in a logic programming language
7. prove some simple non-standard logic theorems

Indicative Literature

Bergmann, Merry. “An Introduction to Many-Valued and Fuzzy Logic: Semantics, Algebras, and Derivation Systems”, Cambridge University Press, April 2008.
Sterling, Leon S., Ehud Y. Shapiro, Ehud Y. "The Art of Prolog", 2nd edition, MIT Press, March 1994.
Fisher, Michael. “An Introduction to Practical Formal Methods Using Temporal Logic”, Wiley, Juli 2011.
Baader, Franz. "The Description Logic Handbook: Theory Implementation and Applications", Cambridge University Press, 2nd edition, May 2010.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written Examination

Duration: 60 min
Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%

8.2.3 Causation and Correlation (perspective I)

<table>
<tr><td colspan="3">Module Name
Causation and Correlation (perspective I)</td><td>Module Code
CTNS-NSK-03</td><td>Level (type)
Year 2
(New Skills)</td><td>CP
2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CTNS-03 | Causation and Correlation | Lecture (online) | 2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Jules Coleman</td><td colspan="3">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory elective for all UG students (one perspective must be chosen)</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

Online lecture (17.5h)
Private study (45h)

Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation</td></tr>
<tr><td colspan="6">Content and Educational Aims

In many ways, life is a journey. And also, as in other journeys, our success or failure depends not only on our personal traits and character, our physical and mental health, but also on the accuracy of our map. We need to know what the world we are navigating is actually like, the how, why and the what of what makes it work the way it does. The natural sciences provide the most important tool we have developed to learn how the world works and why it works the way it does. The social sciences provide the most advanced tools we have to learn how we and other human beings, similar in most ways, different in many others, act and react and what makes them do what they do. In order for our maps to be useful, they must be accurate and correctly reflect the way the natural and social worlds work and why they work as they do.

The natural sciences and social sciences are blessed with enormous amounts of data. In this way, history and the present are gifts to us. To understand how and why the world works the way it does requires that we are able to offer an explanation of it. The data supports a number of possible explanations of it. How are we to choose among potential explanations? Explanations, if sound, will enable us to make reliable predictions about what the future will be like, and also to identify many possibilities that may unfold in the future. But there are differences not just in the degree of confidence we have in our predictions, but in whether some of them are necessary future states or whether all of them are merely possibilities? Thus, there are three related activities at the core of scientific inquiry: understanding where we are now and how we got here (historical); knowing what to expect going forward (prediction); and exploring how we can change the paths we are on (creativity).

At the heart of these activities are certain fundamental concepts, all of which are related to the scientific quest to uncover immutable and unchanging laws of nature. Laws of nature are thought to reflect a causal nexus between a previous event and a future one. There are also true statements that reflect universal or nearly universal connections between events past and present that are not laws of nature because the relationship they express is that of a correlation between events. A working thermostat accurately allows us to determine or even to predict the temperature in the room in which it is located, but it does not explain why the room has the temperature it has. What then is the core difference between causal relationships and correlations? At the same time, we all recognize that given where we are now there are many possible futures for each of us, and even had our lives gone just the slightest bit differently than they have, our present state could well have been very different than it is. The relationship between possible pathways between events that have not materialized but could have is expressed through the idea of counterfactual.</td></tr>
</table>

Creating accurate roadmaps, forming expectations we can rely on, making the world a more verdant and attractive place requires us to understand the concepts of causation, correlation, counterfactual explanation, prediction, necessity, possibility, law of nature and universal generalization. This course is designed precisely to provide the conceptual tools and intellectual skills to implement those concepts in our future readings and research and ultimately in our experimental investigations, and to employ those tools in various disciplines.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to

1. formulate testable hypotheses that are designed to reveal causal connections and those designed to reveal interesting, important and useful correlations.
2. distinguish scientifically interesting correlations from unimportant ones.
3. apply critical thinking skills to evaluate information.
4. understand when and why inquiry into unrealized possibility is important and relevant.

Indicative Literature

Thomas S. Kuhn: The Structure of Scientific Revolutions, Nelson, fourth edition 2012;

Goodman, Nelson. Fact, fiction, and forecast. Harvard University Press, 1983;

Quine, Willard Van Orman, and Joseph Silbert Ullian. The web of belief. Vol. 2. New York: Random house, 1978.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written Examination — Duration/Length: 60 min
Weight: 100%

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

8.2.4 Causation and Correlation (perspective II)

<table>
<tr><td colspan="3">Module Name
Causation and Correlation (perspective II)</td><td>Module Code
CTNS-NSK-04</td><td>Level (type)
Year 2
(New Skills)</td><td>CP
2.5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTNS-04</td><td colspan="3">Causation and Correlations (perspective II)</td><td>Lecture (online)</td><td>2.5</td></tr>
<tr><td>Module Coordinator
Dr. Keivan Mallahi-Karai
Dr. Eoin Ryan Dr. Irina Chiaburu</td><td colspan="3">Program Affiliation
• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status
Mandatory elective for all UG students (one perspective must be chosen)</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements
Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills: Basic probability theory</td><td>Frequency
Annually
(Spring)</td><td colspan="2">Forms of Learning and Teaching
Online lecture (17.5h)
Private study (45h)</td></tr>
<tr><td>Duration
1 semester</td><td colspan="2">Workload
62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation</td></tr>
<tr><td colspan="6">Content and Educational Aims
Causality or causation is a surprisingly difficult concept to understand. David Hume famously noted that causality is a concept that our science and philosophy cannot do without, but it is equally a concept that our science and philosophy cannot describe. Since Hume, the problem of cause has not gone away, and sometimes seems to get even worse (e.g., quantum mechanics confusing previous notions of causality). Yet, ways of doing science that lessen our need to explicitly use causality have become very effective (e.g., huge developments in statistics). Nevertheless, it still seems that the concept of causality is at the core of explaining how the world works, across fields as diverse as physics, medicine, logistics, the law, sociology, and history – and ordinary daily life – through all of which, explanations and predictions in terms of cause and effect remain intuitively central.

Causality remains a thorny problem but, in recent decades, significant progress has occurred, particularly in work by or inspired by Judea Pearl. This work incorporates many 20th century developments, including statistical methods – but with a reemphasis on finding the why, or the cause, behind statistical correlations –, progress in understanding the logic, semantics and metaphysics of conditionals and counterfactuals, developments based on insights from the likes of philosopher Hans Reichenbach or biological statistician Sewall Wright into causal precedence and path analysis, and much more. The result is a new toolkit to identify causes and build causal explanations. Yet even as we get better at identifying causes, this raises new (or old) questions about causality, including metaphysical questions about the nature of causes (and effects, events, objects, etc), but also questions about what we really use causality for (understanding the world as it is or just to glean predictive control of specific outcomes), about how causality is used differently in different fields and activities (is cause in physics the</td></tr>
</table>

same as that in history?), and about how other crucial concepts relate to our concept of cause (space and time seem to be related to causality, but so do concepts of legal and moral responsibility).

This course will introduce students to the mathematical formalism derived from Pearl's work, based on directed acyclic graphs and probability theory. Building upon previous work by Reichenbach and Wright, Pearl defines a "a calculus of interventions" of "do-calculus" for talking about interventions and their relation to causation and counterfactuals. This model has been applied in various areas ranging from econometrics to statistics, where acquiring knowledge about causality is of great importance.

At the same time, the course will not forget some of the metaphysical and epistemological issues around cause, so that students can better critically evaluate putative causal explanations in their full context. Abstractly, such issues involve some of the same philosophical questions Hume already asked, but more practically, it is important to see how metaphysical and epistemological debates surrounding the notion of cause affect scientific practice, and equally if not more importantly, how scientific practice pushes the limits of theory. This course will look at various ways in which empirical data can be transformed into explanations and theories, including the variance approach to causality (characteristic of the positivistic quantitative paradigm), and the process theory of causality (associated with qualitative methodology). Examples and case studies will be relevant for students of the social sciences but also students of the natural/physical world as well.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to

1. have a clear understanding of the history of causal thinking.
2. form a critical understanding of the key debates and controversies surrounding the idea of causality.
3. recognize and apply probabilistic causal models.
4. explain how understanding of causality differs among different disciplines.
5. demonstrate how theoretical thinking about causality has shaped scientific practices.

Indicative Literature

Paul, L. A. and Ned Hall. Causation: A User's Guide. Oxford University Press 2013.

Pearl, Judea. Causality: Models, Reasoning and Inference. Cambridge University Press 2009

Pearl, Judea, Glymour Madelyn and Jewell, Nicolas. Causal Inference in Statistics: A Primer. Wiley 2016

llari, Phyllis McKay and Federica Russo. Causality: Philosophical Theory Meets Scientific Practice. Oxford University Press 2014.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment: Written examination — Duration/Length: 60 min

Weight: 100 %

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

8.3 Language and Humanities Modules

8.3.1 Languages

The descriptions of the language modules are provided in a separate document, the "Language Module Handbook" that can be accessed from the Constructor University's Language & Community Center internet sites (https://constructor.university/student-life/language-community-center/learning-languages).

8.3.2 Humanities

8.3.2.1 Introduction into Philosophical Ethics

<table>
<tr><td colspan="2">Module Name
Introduction to Philosophical Ethics</td><td>Module Code
CTHU-HUM-001</td><td>Level (type)
Year 1</td><td>CP
2.5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP
CTHU-001 | Introduction to Philosophical Ethics | Lecture (online) | 2.5</td></tr>
<tr><td>Module Coordinator

Dr. Eoin Ryan</td><td colspan="2">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory elective</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

Online lectures (17.5 h)
Private Study (45h)

Workload

62.5 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation</td></tr>
<tr><td colspan="5">Content and Educational Aims

The nature of morality – how to lead a life that is good for yourself, and how to be good towards others – has been a central debate in philosophy since the time of Socrates, and it is a topic that continues to be vigorously discussed. This course will introduce students to some of the key aspects of philosophical ethics, including leading normative theories of ethics (e.g. consequentialism or utilitarianism, deontology, virtue ethics, natural law ethics, egoism) as well as some important questions from metaethics (are useful and generalizable ethical claims even possible; what do ethical speech and ethical judgements actually do or explain) and moral psychology (how do abstract ethical principles do when realized by human psychologies). The course will describe ideas that are key factors in ethics (free will, happiness, responsibility, good, evil, religion, rights) and indicate various routes to progress in understanding ethics, as well as some of their difficulties.</td></tr>
</table>

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. describe normative ethical theories such as consequentialism, deontology and virtue ethics.
2. discuss some metaethical concerns.
3. analyze ethical language.
4. highlight complexities and contradictions in typical ethical commitments.
5. indicate common parameters for ethical discussions at individual and social levels.
6. analyze notions such as objectivity, subjectivity, universality, pluralism, value.

Indicative Literature

Simon Blackburn, Being Good (2009)

Russ Shafer-Landay, A Concise Introduction to Ethics (2019)

Mark van Roojen, Metaethicas: A Contemporary Introduction (2015)

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written Examination — Duration/Length: 60 min
Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%

8.3.2.2 Introduction to the Philosophy of Science

<table>
<tr><td colspan="3">Module Name
Introduction to the Philosophy of Science</td><td>Module Code
CTHU-HUM-002</td><td>Level (type)
Year 1</td><td>CP
2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
CTHU-002 | Introduction to the Philosophy of Science | Lecture (online) | 2.5</td></tr>
<tr><td>Module Coordinator

Dr. Eoin Ryan</td><td colspan="3">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory elective</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

Online lectures (17.5h)
Private Study (45h)

Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation</td></tr>
<tr><td colspan="6">Content and Educational Aims

This humanities module will introduce students to some of the central ideas in philosophy of science. Topics will include distinguishing science from pseudo-science, types of inference and the problem of induction, the pros and cons of realism and anti-realism, the role of explanation, the nature of scientific change, the difference between natural and social sciences, scientism and the values of science, as well as some examples from philosophy of the special sciences (e.g., physics, biology). The course aims to give students an understanding of how science produces knowledge, and some of the various contexts and issues which mean this process is never entirely transparent, neutral, or unproblematic. Students will gain a critical understanding of science as a human practice and technology; this will enable them both to better understand the importance and success of science, but also how to properly critique science when appropriate.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

Upon completion of this module, students will be able to

1. understand key ideas from the philosophy of science.
2. discuss different types of inference and rational processes.
3. describe differences between how the natural sciences, social sciences and humanities discover knowledge.
4. identify ways in which science can be more and less value-laden.
5. illustrate some important conceptual leaps in the history of science.</td></tr>
<tr><td colspan="6">Indicative Literature

Peter Godfrey-Smith, Theory and Reality (2021)

James Ladyman, Understanding Philosophy of Science (2002)

Paul Song, Philosophy of Science: Perspectives from Scientists (2022)</td></tr>
<tr><td colspan="6">Usability and Relationship to other Modules</td></tr>
<tr><td colspan="6">Examination Type: Module Examination

Assessment Type: Written Examination | Duration/Length: 60 min</td></tr>
</table>

Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

8.3.2.3 Introduction to Visual Culture

Module Name			**Module Code**	**Level (type)**	**CP**
Introduction to Visual Culture			CTHU-HUM-003	Year 1	2.5
Module Components					
Number	Name			Type	CP
CTHU-003	Introduction to Visual Culture			Lecture (online)	2.5
Module Coordinator Dr. Irina Chiaburu	**Program Affiliation** • CONSTRUCTOR Track Area			**Mandatory Status** Mandatory elective	
Entry Requirements			**Frequency**	**Forms of Learning and Teaching**	
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring/Fall)	Online Lecture	
☒ none	☒ none	•	**Duration**	**Workload**	
			1 semester	62.5 h	

Recommendations for Preparation

Content and Educational Aims

Of the five senses, the sense of sight has for a long time occupied the central position in human cultures. As John Berger has suggested this could be because we can see and recognize the world around us before we learn how to speak. Images have been with us since the earliest days of the human history. In fact, the earliest records of human history are images found on cave walls across the world. We use images to capture abstract ideas, to catalogue and organize the world, to represent the world, to capture specific moments, to trace time and change, to tell stories, to express feelings, to better understand, to provide evidence and more. At the same time, images exert their power on us, seducing us into believing in their 'innocence', that is into forgetting that as representations they are also interpretations, i.e., a particular version of the world.

The purpose of this course is to explore multiple ways in which images and the visual in general mediate and structure human experiences and practices from more specialized discourses, e.g., scientific discourses, to more informal and personal day-to-day practices, such as self-fashioning in cyberspace. We will look at how social and historical contexts affect how we see, as well as what is visible and what is not. We will explore the centrality of the visual to the intellectual activity, from early genres of scientific drawing to visualizations of big data. We will examine whether one can speak of visual culture of protest, look at the relationship between looking and subjectivity and, most importantly, ponder the relationship between the visual and the real.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. understand a range of key concepts pertaining to visual culture, art theory and cultural analysis
2. understand the role visuality plays in development and maintenance of political, social, and intellectual discourses
3. think critically about images and their contexts
4. reflect critically on the connection between seeing and knowing

Indicative Literature

Berger, J., Blomberg, S., Fox, C., Dibb, M., & Hollis, R. (1973). Ways of seeing.
Foucault, M. (2002). The order of things: an archaeology of the human sciences (Ser. Routledge classics). Routledge.
Hunt, L. (2004). Politics, culture, and class in the French revolution: twentieth anniversary edition, with a new preface (Ser. Studies on the history of society and culture, 1). University of California Press.
Miller, V. (2020). Understanding digital culture (Second). SAGE.
Thomas, N. (1994). Colonialism's culture: anthropology, travel and government. Polity Press.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment: Written examination — Duration/Length: 60 min.
Weight: 100%

Scope: all intended learning outcomes

Completion: To pass this module, the examination has to be passed with at least 45%

9 Appendix

9.1 Intended Learning Outcomes Assessment-Matrix

Industrial Engineering & Management BSc					General Logistics	General IE	Intro to Int. Business	Intro to Finance & Accounting	Process Model and Simulation	Operations Research	Applied Project Management	Lean Supply Man	Product and Pr System Design	Prod Planning & Control	Data Managm. & Analytics in Industry 4.0	Int. Strategic Management	Industry 4.0 and Blockchain Tech.	Advanced Product Design	Supply Chain Design	Integrated Decision Making in SCM	Distribution & E-commerce	Law of Transportation, For. and Log.	Machine Learning	Internship	Bachelor's Thesis	CT Methods	CT New Skills	CT Language / Humanities
Semester					1	2	1	2	3	3	3	3/4	3/4	4	4	4	6	6	6	6	6	6	6	5	6	1-4	3-6	1-2
Mandatory (m) / Mandatory Elective (me)					m	m	m	m	m	m	me	m	m	m	m	me	me	me	me	me	me	me	me	m	m	m	me	me
Credits					7.5	7.5	7.5	7.5	5	5	7.5	5	5	5	5	7.5	5	5	2.5	2.5	2.5	2.5	5	30	15	20	20	5
	Competencies*																											
Program Learning Outcomes	**A**	**E**	**P**	**S**																								
apply knowledge of engineering, management, logistics, and mathematics to identify, formulate, and solve problems in the field of industrial engineering	x	x			x	x	x	x	x	x	x	x	x	x	x	x							x	x	x			
use current academic techniques, skills, and modern industrial engineering and management tools necessary for industrial practice (e.g. ABC/XYZ Analysis, Value Stream Mapping, Process Modeling and Simulation, Linear Programming, Demand Forecasting Methods, CAD drawings, Porter's 5 Forces, SWOT & PESTEL analyses, Business Model Canvas, etc.)	x	x			x	x	x	x	x	x	x	x	x	x	x	x							x	x		x		
create solutions to real industrial situations applying principles of industrial engineering, business administration, strategy, logistics and supply chain management (as seen in case studies and examples in class)		x			x	x	x	x	x		x	x				x	x	x	x	x	x	x	x				
design and conduct experiments, as well as to analyze and interpret data with the help of software (e.g. R) and programming languages (e.g. Python)	x	x							x	x												x			x		
design a system or process to meet desired needs within realistic constraints such as economic, environmental, social, health and safety, manufacturability, and sustainability		x			x	x			x	x			x	x	x		x	x	x	x	x		x				
critically analyze industrial problems and make operational and strategic decisions involving complex or conflicting objectives		x			x	x				x				x	x		x	x	x	x	x	x					
discuss financial issues of a project and provide structured management reports about project progress		x					x	x			x					x				x								
take on responsibility in and lead a diverse and multidisciplinary team consisting of both technical and management professionals		x	x								x			x	x	x	x	x	x	x	x					x	
professionally communicate their conclusions and recommendations in both spoken and written form, the underlying information and their reasons to specialists and non-specialists both clearly and unambiguously based on the state of research and application		x	x								x				x	x	x	x	x	x	x		x	x		x	x
discuss how the political, economic, social, and technological environments affect business functions in a globalized world	x	x		x	x		x					x				x						x						
use academic or scientific methods as appropriate in the field of industrial engineering and management such as defining research questions, justifying methods, collecting, assessing and interpreting relevant information, and drawing scientifically-founded conclusions that consider social, scientific and ethical insights	x	x	x	x																					x			
develop and advance solutions to problems and arguments in their subject area and defend these in discussions with specialists and non-specialists	x	x															x	x	x	x	x			x	x		x	x
engage ethically with academic, professional and wider communities and to actively contribute to a sustainable future, reflecting and respecting different views	x	x	x	x																		x		x	x		x	x
take responsibility for their own learning, personal and professional development and role in society, evaluating critical feedback and self-analysis			x	x							x	x												x			x	x
apply their knowledge and understanding to a professional context	x	x	x				x	x			x					x								x			x	x
adhere to and defend ethical, scientific and professional standards	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Assessment Type																												
Oral examination																												x
Written examination					x	x	x	x		x		x	x	x								x	x			x	x	x
Essay																												x
Project assessment					x	x			x				x		x		x	x	x	x	x							
Project report																								x				
Term paper												x				x												
Laboratory report																												
Poster presentation																								x	x			
Presentation											x																x	x
Thesis																									x			
Module achievements							x																					x

*Competencies: A-scientific/academic proficiency; E-competence for qualified employment; P-development of personality; S-competence for engagement in society

Figure 4: Intended Learning Outcomes Assessment-Matrix