B2e: Programme-specific appendix to the EER 2017-2018

For the bachelor of science programme

Industrial Engineering and Management

1 Structure and content of the programme

The Bachelor's programme in Industrial Engineering and Management Science (IEM) consists of three academic years (B1, B2 and B3) of 60 ECs each. The academic timetable for the Bachelor's programme consists of two semesters per academic year, each semester consisting of two quartiles of ten weeks each. A quartile consists of one unit of study, a 'module' of 15 EC (420 hours).

The programme consists of 12 modules of which 10 modules are the core of the programme. The two first modules (semester 5) of the third year are electives for broadening or deepening knowledge, skills and attitude or study abroad. The two last modules of the programme (semester 6) is the preparation and the execution of the bachelor's thesis assignment in which the student shows to master all programme intended learning outcomes.

Each module is composed of different components which are logically clustered around a particular topic in such a way that the offered knowledge, skills and attitude of different scientific disciplines and approaches are applied in cases, assignments and/or the project. Students work in groups on project-oriented assignments and gain new knowledge rather independently (under the support and supervision of tutors). Such a teaching approach requires a variety of assessment methods – individual and group assignments, individual written tests, group papers and presentations, etc. - which are applied at different phases in each module. More detailed information on the exam formats can be found in the module descriptions, including the test plan, in the Student Information System - Osiris and at the Blackboard site.

1.1 Programme

The global overview of the IEM programme is given in Table 1.

BSc Industrial Engineering and Management

Study Programme 2017 - 2018

IEMS	Quartile	module code	module Name	Mandatory prior knowledge	Necessary knowlegde
year 1	1	201300023	Module 1: Introduction to IEM		
	2	201300024	Module 2: Operations Management		
	3	201300108	Module 3: Business Intelligence and IT		
	4	201300109	Module 4: Supply Chain Management		M2
year 2	1	201400056	Module 5: Finance for Engineers	75% B1	
	2	201400265	Module 6: Consumer products		
	3	201400060	Module 7: From product design to online business		
	4	201400062	Module 8: Modeling and analysis of stochastic proccesses for IEM		M2, M4
year 3	1		Module 9: Elective	75EC	
	2		Module 10: Elective		
	3	201500021	Module 11: Preparation thesis		
	4	201500022	Module 12 Thesis	150EC incl M11	

Table 1: Study programme BSc Industrial Engineering and Management

The above scheme shows:

- The module sequence per year and the quartile in which the module is offered
- The module code and module name (registered in the Student Information System - SIS)
- Mandatory prior knowledge: Knowledge to be allowed to start the next module of the study
- Necessary knowledge: prior knowledge necessary to be able to finish the module

Content of practical exercises
A practical exercise is a unit of study or a part of a unit of study, in which the emphasis is placed on the student's activities. In the Twente Educational Model (TEM) on which the IEM curriculum is based, practical exercises and relations with the work field play an important role, especially in the form of a project (or sometimes several small projects) which is at the heart of each module. The structure of the practical exercise(s) is described on Blackboard.

1.2 Study Load

The programme has a study load of 180 EC. This means three years study and a total amount of 5040 hours of study. Each EC represents 28 hours of study.

1.3 Specific characteristics

IEM is a fulltime programme. The programme consist of:
- A major: 10 core modules
- A minor: two elective modules, scheduled in the first semester of the third year. The minor can be taken at the University of Twente, universities in the Netherlands, or abroad.

1.4 Honours programmes

Students obtaining excellent results will be invited for participation in the University-excellence honours programmes for broadening their knowledge. These programmes offer additional education to the programme. Participation means extra study load. Finalizing the excellence programme will be noted on the diploma supplement. Recommendation for participation is mandated to the study counselor. For extra information, see http://www.utwente.nl/excellentie/honoursprogramma/

Students can opt for the TBK 'TALENT' programme (extra), in which they can deepen their knowledge for 15 to 30EC within the IEM domain.

2 Aim and final attainment targets

As envisioned in UT's 'High Tech Human Touch' vision, IEM particularly focuses on organizational problems in contexts with high societal relevance. IEM students can analyse the root causes, can design solutions, can prospectively assess solutions in a (mathematical/simulation) model, and can implement the outcomes in situations where typically they need to work together with people from various other disciplines. IEM graduates specifically are able to support scientific decision making, by choosing a method that fits the problem, which means that they combine quantitative and problem-solving approaches of engineers with research methods and qualitative insights from the social sciences. The domain of IEM is dynamic. Demands posed on graduates shift towards e.g. stronger skills and multidisciplinary competences. This shift is driven by developments of e.g. globalization of supply chains, risk management and financial valuing, and the search for higher efficiency and effectiveness in the healthcare sector.

The aim is to enhance the student experience, improve study success, and grow an entrepreneurial student attitude. Our project-based learning approach challenges students to solve a real-life HTHT case (project) in each of the four second year multidisciplinary teaching units (15 EC). The integration of all education in these modules provides a context in which knowledge, skills and attitude will sink in better. Indeed, students have to acquire these competences and immediately apply them to be able to complete their projects. Since various modules are shared between programmes, students have to work in multidisciplinary teams.

The programme leads to a T-shaped profile of BSc graduates with high level academic and professional skills. In support of the horizontal bar of the 'T', throughout the BSc programme, all UT students have 10 EC of reflection on science and corporate and social responsibility. Also, all engineering programmes share the mathematics learning line.

2.1 Intended learning outcomes (ILOs)

The ILOs of the degree IEM programmes correspond to the requirements formulated by colleagues in the Netherlands and abroad, and by professional practice.
We distinguish two groups of competences: domain-specific and general competences, with a specific operationalization on general skills: reflection, working in (multidisciplinary) teams and preparation of student's lifelong learning, ethics, philosophy of science and Corporate Social Responsibility. Table 2 outlines the ILOs.

	BSc Intended Learning Outcomes
	The graduate is able to identify, comprehend, assess, correctly apply, and integrate existing scientific knowledge that can be used for analyzing problems and designing solutions, in the domains of: o production and logistics; o information systems; o finance and accounting; o other fields in business administration (law; marketing; human resources); o mathematics, statistics, empirical research methods. This implies the following competencies
A1	Has a global overview of the structure of research and design processes and is able to - identify the various steps in performed research and design - properly break up own research and design activities into sub processes These processes are intertwined: Research is needed for producing knowledge that is used for designing solutions in a specific context. Such knowledge is produced in a purposeful and methodical way (using scientific research methods). It may or may not be generalizable knowledge
A2	Has an overview of quantitative and qualitative empirical research methods and is able to - analyze performed research as to the methodological aspects - select an appropriate method and explain this choice for research to be performed - apply this method in relatively simple cases
A3	Has an overview of quantitative modeling techniques for operational processes, specifically in the domains of o Operations research models o Information systems models and data analytics o Finance and accounting models and is able to - analyze the results of modeling activities - select an appropriate modeling technique and explain this choice - apply this technique in relatively simple cases.
A4	Is able to integrate existing knowledge, modeling techniques, and research results for designing, validating, and selecting solutions in relatively simple cases This is challenging, because existing knowledge may not fully apply to a specific situation, models are always stylized, empirical research always has limitations, and some aspects have been left out of scope from the beginning anyway
A5	Has an overview of implementation methods and processes and is able to - (critically) analyze ongoing or finished implementation processes - plan globally an implementation process in a relatively simple case
A6	Has an overview of evaluation methods and techniques and is able to - analyze the results of performed evaluations - select appropriate evaluation methods and explain this choice - carry out an evaluation in relatively simple cases
A7	In order to be able to meet these competencies, the graduate must have mastered the following disciplines: - mathematics and statistics level 2[1] - finance and accounting level 2 - production and logistics level 2 - information systems level 2 - law, organization theory, marketing level 1
	BSc final qualifications
B1	Is able to work autonomously and self-reliant
B2	Is able to work in (multi)-disciplinary teams.
B3	Is able to communicate properly (in oral and written form) with various stakeholders
B4	Is able to conduct a bibliographic search and knows how to reference correctly
B5	Is able to reflect on professional behavior and ethical and societal aspects of work
B6	Is able to reflect on and direct personal and professional development
B7	Is able to manage and concretize effectively his own learning process in the context of a MSc program.
B8	Has enough basic knowledge and competencies to follow a broad range of MSc programmes which are adjacent to the IEM domain.

[1] *Level 1 = knowledge of the basic concepts and principles; level 2 = application in relatively simple and monodisciplinary cases; level 3 = application in complex and interdisciplinary cases*

Table 2: Intented Learning Outcomes

2.2 Connecting master

Successfully completing the BSc IEM programme automatically qualifies a student for immediate admission to the MSc programme Industrial Engineering and Management.

3 Examination and exams

3.1 Examination

The IEM Bachelor's programme exam is successfully completed if all the exams of the units of study (modules), including the minor, have been taken successfully.

3.2 Exam formats and the number and sequence of exams

The exam format of (module) exams consist of a mixture of assessment methods. These may include individual and group assessment (various forms) of practical exercises, written test and reports, different forms of presentations (poster, verbal, paper). For each module the intended learning outcomes and a generic test plan is given below[2].

As mentioned before 'each module is composed of different components which are logically clustered around a particular topic in such a way that the offered knowledge, skills and attitude of different scientific disciplines and approaches are applied in the project'. **Each module is graded with one integrated exam grade.** The exam grade consists of grades of module components.

- The module test grade is registered if all module components are successfully finished
- Participating in practical exercises is mandatory
- Grading and feedback of individual skills assignments are registered in the personal student's portfolio. Up keeping the portfolio is student's responsibility.

3.3 Determination of the exam grade:

- The exam grade is determined based on the module test plan, defined by the module coordinator. De exam grade is at least 5.5 to finish the module successfully. In SIS the module grade is rounded towards the nearest integer
- The project grade is at least 5.5. The grades of module components are at least 5.5, unless described otherwise in the test plan
- The module coordinator determines in the test scheme if and what compensation regulation is applied in the module
- If a module component grade is equal to NVD, the exam grade also is equal to NVD.

3.4 Bachelor thesis (assignment)

During the thesis graduation project students have to work individually and independently on a chosen subject of professional relevance in a company or institution in the Netherlands or abroad. *The individual graduation project* is an external research assignment, in which students have to show that they meet the programme intended learning outcomes. The graduation project involves the assessment of the total research process and of two deliverables, the Bachelor's graduation report and the presentation/defence of the research outcomes. The student is academically supervised by two examiners; an external supervisor takes care of daily supervision. The lead UT examiner is an expert on the assignment subject. The lead UT examiner monitors the progress of the project and grades the work, together with the second UT examiner. Only appointed UT-IEM examiners are authorized to grade the project; however, external supervisors are consulted as well. The final grade is based on the criteria of a detailed Bachelor Project Assessment form.

The bachelor thesis assignment has to be finished within the nominal study time (10 weeks). Reasons for delay can be:

[2] *Be aware that small changes to module test plans will be published on Blackboard.*

- Insufficient level of and/or progress by the student
- Insufficient (level of) supervision in the specific research topic
- Special circumstances

Extra graduation project time can only be authorized by the Education Director with a maximum of 50% (5 weeks). De Education Director can ask for advice of the supervisors and/or study counselor.

If the assignment is not finished within the time set and on a sufficient level then the assignment may be graded as insufficient. The student then has to do a new assignment. The student can ask for appeal at the Examination Board against the decision of the Education Director. Extra information regarding the Bachelor graduation project can be found on the Blackboard site.

3.5 Prior Knowledge

The formal sequence of the modules and their exams is the order as recorded in Table 1. Departing from the order of modules needs approval from the study counselor on behalf of the Education Director.

4 General Information

4.1 Admittance to the programme

In addition to the stipulations in Article 4 of the Common Elements of this OER and the admission regulations laid down in the 'Colloquium Doctum', there are no extra statutory requirements.

4.2 Language of teaching and exams

The BSc programme is taught in English. All course materials (textbooks, readers, etc.) will be in English as well as the tests, exams and practical exercises.

4.3 International cooperation

The BSc programme and its staff cooperate internationally with a large number of institutes and companies. Students are stimulated to benefit from these cooperations for their international experience.
The options for an international experience are:

- Study abroad: In the first semester of the third year students can choose for a semester (30EC) study abroad (exchange) at partner universities. Arrangements for study abroad at non-partner universities are subject to special procedures and requirements as specified on the UT study abroad website and the BMS Blackboard Organization Study Abroad.
- The minor 'crossing boarders' give students the opportunity to go abroad for a field study or a study tour. For more information we refer to the website www.utwente.nl/minor
- Executing a bachelor thesis project abroad. Students can organize a thesis project on their own initiative. The thesis project needs approval from the supervisor before the start of the project execution.

4.4 Electives and extra options

During the third year students have the following choices:

- Students can choose to do two 15EC minor modules at the UT. Offered are: High Tech Human Touch minors, Crossing Border minor, join-in minors, in-depth minors and study abroad (exchange). Minors may have admission requirements. For more information see the website www.utwente.nl/minor and the minor matrix.
- An additional choice is participation at the excellence programme at University level (https://www.utwente.nl/en/excellence/) or the IEM TALENT programme, see Blackboard Organization 'IEM Programme Information'.
- Students can choose the subject of their Bachelor thesis project and the country which they would like to execute your research.

Students can participate in UT minors without approval of the Examination Board or the Education Director. The exchange programme for study abroad needs approval of the Education Director, on behalf of the Examination Board.

4.5 Programme committee

For the Bsc and MSc programme Industrial Engineering and Management a programme committee (OLC) is appointed by the Dean. The committee is the advisory board for the Education Director.
The OLC consists of students and lectures from the programmes on an equal basis. The members of the committee can be found on the website.
Tasks of the OLC are:

- Advising on teaching and examination regulations (EER)
- Assessing the manner in which the EER is carried out
- Advising (invited or not invited) on teaching and education issues related to both BSc and MSc programme

4.6 Examination Board (EB)

The EB Management Science is the body that determines in an objective and expert manner whether a student meets the conditions set under the EER concerning the knowledge, comprehension and skills required to obtain a degree. The EB's main tasks are described in the common elements of this EER.
The members of the EB, appointed by the Dean, can be found on the website: https://www.utwente.nl/en/bms/examboard/. Correspondence with the EB is possible via their website.

4.7 Description of the BSc Technische Bedrijfskunde programme assessment system

The faculty BMS adopted the BMS assessment policy plan in the spring of 2016. Currently, IEM is aligned with the policy plan and working with closed PDCA cycles. A key instrument is the program test plan (available on request).

4.7.1 Examination Board

The BMS faculty has four EBs. One of these covers four degree programs, including our BSc and MSc programs. The EB has one UT-external member. Program management and EB have a mutually proactive understanding. Areas of attention are: 1) Intended learning Outcome (ILO) structure on program and module level; 2) assessment of BSc theses; 3) testing schemes (including the relationships with FQs); 4) quality of tests at the module level; 5) the assessment qualifications of examiners; 6) oversight of organizational aspects of testing and assessment. All of the EB's duties are in line with Dutch WHW legislation. Annually, the EB and the program management discuss progress. The EB hands in an annual report of the findings to the Dean.

4.7.2 Description of the program's assessment system

The program director is responsible for the design of the program and for the process of testing and assessment. A program test plan and a test framework are the basis for quality assurance of assessment. Actions for improvements and results are recorded in an annual Program Improvement Plan. These documents are discussed with the program committee, the lecturers and the EB. The program assurance instrument for testing and assessment has five levels: 1) The program, 2) the module, 3) a test, 4) final assignments and 5) examiners. We will cover these below.

4.7.3 Assessment quality assurance at the program level

At the program level a comprehensive test plan gives an overview of what, how and when program goals are tested, to ensure that each individual student achieves the required FQs.

4.7.4 Assessment quality assurance at the level of a module

Our 15 EC modules contain several tests. Each module is completed with a formal assessment, i.e. an assessment for a grade. A variety of both summative and formative testing and assessment methods is used, to cover the variety of learning goals and to support students' learning. The module test plan also includes the learning objectives at the level of a module, a test schedule and the proportion of individual and group assignments per module, to ensure that these are good 'building blocks' for the design of the tests and that they are doable for students. The test plan is updated yearly and discussed with the Examination Board.

4.7.5 The tests

SIS and Blackboard provide information to students about all aspects of the modules intended learning objectives, the test plan, module grading etc. concerning the module. Lecturers provide representative practice assignments and feedback, and/or trial tests. As for project work it is clearly stated how the mark is determined. The assessment in the project subjects may be composed of various components, such as a presentation, oral examination, a final report and of course the process. Students can re-sit tests once within a module. For a second resit, students must submit a motivated request to the EB. Some modules have limited compensation possibilities.

4.7.6 Quality assurance of a test

- *Organization and responsibility:* The module coordinator, also being the coordinating examiner, bears the responsibility for the design, planning, realization, evaluation and improvement of the module, in cooperation with the module examiners. A student passes the 'module' examination when all 'interim' examinations (*tests*) for his/her module have been completed.
- *Questionnaires:* BMS' education quality department annually evaluates each module through standard questionnaires.
- *Panel meetings:* Each quartile students are invited to participate in a panel meeting (week 4/5 of the module) for an interim evaluation, possibly leading to improve ongoing education.
- *Students:* Due to the informal culture and communication, students feel free to discuss complaints and/or improvement to courses, test and assessment with lecturers and management directly.
- *Study Association:* Stress organizes meetings for the students for discussing the quality of education, including testing. Feedback is given to the program management, who discuss possible issues with the lecturer.
- *UT complaints desk:* If reporting complaints does not lead to any acceptable change or adaption, students can report the complaint to the UT complaints desks (part of the UT student counseling service). The complaint will be dealt with by the Board of Appeal for Examinations, the Arbitration Committee or the Complaints Committee.
- *Lecturer meetings* to discuss (skills) assignments and test results.
- *Test screening:* for the quality assurance of tests, an independent process of test screening was started in 2014 at the request of the program director. Each academic year one module, including all of its individual tests, is screened by independent educationalists (CES-CELT). The screening results and suggestions for improvement are discussed with the examiner(s), educationalists and the program management. The examiner addresses actions from the screening report. Aggregate reporting is provided to the Examination Board. The following year the follow-up of the actions is monitored by the program management and the module coordinator through questionnaires and test analyses by the examiners.
- *The individual graduation project,* an external research assignment, involves the assessment of the process and of two deliverables, the Bachelor's graduation report and the defense of the research outcomes. The student is academically supervised by two examiners; an external supervisor takes care of daily supervision. The lead UT supervisor is an expert on the assignment subject. He monitors the progress of the project and grades the work. Only appointed UT-IEM examiners are authorized to grade the project; however, external supervisors are consulted as well. The final mark is based on the criteria of a detailed Bachelor Project Assessment form.

4.7.7 Improvement or modification of a test

The module coordinator and module examiners evaluate and analyze the subject test results and consider adjustments for the coming year. Small adjustments are noted by the examiner while major adjustments are submitted to the EB and posted in a course improvement plan.

4.7.8 Assessment of qualifications of lecturers/examiners

To assure and enhance the examiners' testing quality, examiners are specifically trained in educational testing and analysis of results (e.g. UTQ). Yearly an examiners overview per module is offered to the EB for screening and approval. All examiners are competent. The test screening is expected to provide further inputs for enhancements.

4.7.9 Fraud/Plagiarism

The Education and Examination Regulation (EER) includes handling of cases of alleged fraud, which is also covered in the Rules and Guidelines (*Regels en Richtlijnen*) of the Examination Board. At the program level, students are instructed about fraud and plagiarism in several ways. For written exams, IEM works with external observers and examiners. For written assignment work, IEM has a digital fraud scanner, Ephorus, which is integrated in Blackboard.

4.7.10 Organizational aspects of testing and assessment

EB and education management make formal arrangements. The Centre Educational Support (CES) organizes the timetabled assessments ('interim' examinations and presentation sessions). Where a course is to be completed with a written 'interim' examination, there are annually two opportunities to take this examination. Marking (checking) times and inspection rights are prescribed in the Education and Examination Regulation (OER).

5 Transitional arrangement

For the BSc programme a transitional arrangement is effective due to changes in the mathematics content per 2017-2018. Students enrolled for a transitional resit have to contact the lecturer at the start of the test.

6 (Binding) recommendations on the continuation of studies (Binding Study Advise)

As formulated in the Common EER, Article 6.3, students get a (binding) recommendation regarding their study progress during the first year and on the continuation of studies at the end of the first year.
This recommendation is based on the number of successfully finished modules and ECs together with the advice of the study counselor to the Education Director. **A negative recommendation at the end of the first year is binding**. A student who gets a negative (binding) recommendation cannot enroll in this BSc programme for the next three years. A positive recommendation at the end of the first year is given if the student meets the criteria below.

A positive recommendation on the continuation of studies for the BSc programme IEM can be attained in two ways. The student:

1. Successfully finished 75% of the first year study load, as defined in Article 6.3, paragraph 7.
2. Demonstrated sufficient analytical skills through meeting <u>all</u> of the following criteria:
   A. At least 75% of the total study load has been finished successfully (based on the weight of the tests)
   B. Two modules have been completed successfully
   C. For each module the project has been completed successfully
   D. Of the two not successfully finished modules, at least for one module the student <u>only failed one individual test</u>
   E. At least three of the following conditions have been met (passing a test means that its result is at least 5.5):
      i. All Mathematic tests have been passed (M1, M2, M4)
      ii. All Statistics and Probability tests have been passed (M1, M3, M4)
      iii. The Operations Research test has been passed (M2)
      iv. The Demand/Supply plan, Inventory test has been passed (M4)

Obtaining a positive BSA through item 2 does not imply that the results of the module components of the not finished modules are declared indefinitely valid. In some cases, however, the validity of module components may be extended. See Section 6.1. The Education Director has to approve the positive recommendations on the continuation of studies.

If a student de-enrolls before February 1st, the student is not allowed to register for IEM modules until the next academic year

6.1 Extra test opportunity during the next academic year

Starting point of the 'extra test opportunity during the next academic year is that students should preferably finish

60EC each year, or at least 45EC each year, so they will graduate within four years. Student's study progress will be checked each year in August. To prevent inequitable study delay the IEM programme applies the rules in Sections 6.1.1 to 6.1.3.

6.1.1 Extra test opportunity for unfinished B1 (first year) and B2 (second year) modules

To be allowed to take an 'extra test opportunity' for an unfinished module a student has to meet the following criteria:

- A minimum of 75% of the yearly study load has been finished successfully (based on the weights of the tests)
- Two modules of the student's current academic year have been finished completely.
  'Modules of the student's current academic year' means: modules of the first year (B1) of the IEM programme for students in their first year of enrollment, modules of the second year (B2) of the IEM programme for students in their second year of enrollment.
- Of the module(s) not finished successfully, the student failed only one individual test

If a student meets the criteria an 'extra test opportunity' for the one individual test will be offered during the next academic year. The compensation rules, as determined by the module coordinator and stated in the module description, in force during the academic year the student enrolled in the module the first time, will still be in force at the time of the extra test opportunity.

The 'extra test opportunity' is only valid during the next academic year. If the student fails the 'extra test opportunity' (s)he will have to redo the entire module (except for successfully finished parts of this module of which the results remain valid).

6.1.2 Test opportunity for third year modules

The third year (B3) consists of two elective modules, the thesis preparation and the thesis project.

- For the elective modules the rules of the offering programme are applicable.
- IEM offers the elective HTHT module: Aerospace Management & Operations. For this module the lecturer determines the test opportunities which will be described in the module manual on the Blackboard site.
- Module 11: Preparation Thesis is flexible and individual. For specific information we refer to its Blackboard site.
- Module 12: Thesis is flexible and individual. See its Blackboard site.

6.1.3 Special circumstances

Personal circumstances can lead to adjustment of the criteria for extra test opportunities. The conditions set for an extra test opportunity depend on the situation of the student. In any case conditions are:

- The student reports the disability or (foreseen) personal circumstances to the study counselor (preferably beforehand or as soon as possible)
- The Examination Board recognizes the special circumstances
- The maximum delay for an extra test opportunity is one academic year (the year following the year in which the delay is requested) unless the Examination Board decides otherwise

In case of extreme, unforeseen circumstances, not covered with the above mentioned, the Examination Board will be asked for advice. The best possible solution will be discussed by mutual agreement. The Education Director takes the final decision. The study counselor can be consulted for extra information and advice.

7 Other

7.1 Graduation with distinction (Cum laude)

The IEM programme has a regulation for graduating with distinction for the bachelor's degree programme. If the Bachelor's examination, the student has given evidence of exceptional capability, 'cum laude' (with distinction) will be recorded on the degree certificate.
A student is considered to have exceptional capability if each of the following conditions is met:

a. the weighted average grade awarded for the individual tests, as registered in SIS, for the study units of the first year (B1), the second year (B2) and Module 11 of the third year (B3), is at least 8.0; to calculate this weighted average grade, the weights in SIS are used;

b. in the determination of this average, the units or individual tests that were not evaluated with a numerical grade or for which an exemption was granted, are not taken into account; note that the grade of the bachelor's project is also not included in the calculation;
c. no individual test of a study unit was evaluated as fail or evaluated with a grade < 5.5;
d. the grade for the final unit (Bachelor's project or bachelor's thesis) is at least an 8;
e. the programme must have been completed within four years, unless special circumstances justify the delay, to be determined by the Examination Board.

In exceptional cases the Examination Board may grant the designation of „graduation with distinction" if the conditions mentioned above have not been fully met. The rules applied by the Examination Board can be found in the Rules & Regulations of the Examination Board.

8 Intended learning outcomes, Weights and EC's per module

Module1: Introduction to IEM (Industrial Engineering and Management)

M1	**Introduction to IEM**
PLM	***Productie & Supply Chain***
	The student knows the different operations and modes of production controlling and internal logistics
	The student knows and has historical awareness of production controlling and internal logistics since the industrial revolution until today and its significant developments in technology, operations and information provision.
	The student can analyze and calculate simple growth and bottleneck scenarios using Microsoft Excel
	Supply Chain Management and Sourcing
	The student knows the terms supply chain and bullwhip effect and knows what the causes of the bullwhip effect are
	The student knows the possibilities of information sharing in the supply chain as well as which actual technologies and ways to organize the supply chain can reduce the bullwhip effect, prevent it or how it can lead to a quickly adaptable supply chain.
	The student can describe and draw a supply chain with its shape, dependencies and actors based on a simplified case description
	The student can analyze actions of different actors in the supply chain and also indicate which measures could lead to a reduction of the bullwhip effect.
FEM	*financial management*
	The student has encountered several aspects of financial analysis and financial management in a business context
	The student knows some basic principles of and complications with valuation problems in business context.
	The student has encountered principles behind valuation from an investor's perspective and has started thinking about the sense and nonsense of investing advice.
ITM	*Information management*
	The student is capable of describing the latest ICT technologies in a business context.
	2. The student knows different business information systems (ES/ERP, MIS/SCM), the different characteristics, goals and its applications.
	3. The student can analyze a new service or an improvement of an existing process using the Business Model Canvas by Osterwalder and an enterprise architecture
	Excel, types graphics, tables, functions
	The student gets familiar with Excel by using several types of graphs, tables and functions and can analyze, clean, sort and represent (graphically or numerically) data
	The student gets familiar with abstracting big quantities of data, the difference in meaning between physical variables and programming variables (timestamps, etc.).
	VBA: The student knows the basic functionality of VBA and can make pivot tables based on data and apply it in graphs
	The student can design an interactive worksheet, by using sliders (or what-if analysis), where the results from changing a particular variable can be observed
	The student knows the Monte Carlo simulation and the underlying principles
M&T - Math	***Math A1 (Euclides);*** *The students is able to:*
	Clearly express formulations: work with elementary properties of sets, logic and construct elementary proofs.
	The student can work with the fundamental properties of logic.
	Math B1 (Leibniz); *The students is able to:*
	work with vectors and elementary properties of functions, especially with the rules of differentiability
	Work with limits and the definitions of continuity and differentiability and applications, for functions of 1 variable
	Investigate functions in two variables
M&T - S&P	*Statistics and probability*
	The student knows and can apply elementary statistics and probability, like conditional probabilities and independence.
	The student knows about the probability distribution of one or multiple stochastic variables and the characteristic elements like expectation, variance and correlation coefficient and can calculate probabilities and measures in practical examples.

	The student knows basic distributions for numbers (discreet) and interval variables (continuous), among others the normal and binomial distribution and recognizes these and can apply them in described practical situations
M&T - Meth	*basics of research methodology and applying*
	Can identify the basics of research methodology and is able to apply them
	Apply the cycles for *design*, *research* and *decision-making* and hence experience that this can be done systematically, as opposed to with merely 'common sense'
	recognize the pros and cons of a systematic versus a common sense approach
	Recognize key elements of *design* (action problems), *research* (knowledge problems) and *decision-making* (attractiveness of options, scores, weights). Just the 'what', not the 'why' and 'how'.
BA	*Organization Strategy and structures*
	The student understands Organizational structures and can apply them
Skills	*Academic and professional skills*
	The student has gained insight into the possible personal learning styles, in study planning and time management and can describe ways of improvement.
	The student has gained insight into his or her reading, presenting and writing skills as well as his or her skills for working in a team

Module 1	weight	EC
Core topics	0	1
Methodology	10	1
Excel/VBA	0	1,5
Probability	20	2
Mathematics *	30	4
Skills	0	1,5
Project	40	4
Total	100	15

*** results ≥ 5.5 remain valid**

Module 2: Operations Management

M2	Operations Management
PLM	*Operations Research*
	Is able to formulate LP- and ILP- models for appropriate problems and is able to solve an (I)LP- model using a computer package and to analyze the computer output
	Has knowledge of and insight in the role of inventories in organizations, and can apply (simple) quantitative techniques for inventory optimization in case demand is deterministic as well as stochastic
	Has knowledge of and insight in queuing models and their behavior and is able to model an appropriate problem as a queuing model and to calculate relevant performance indicators like average queue length, and average waiting and sojourn time;
	Understands the idea behind dynamic programming and can model simple problems as DP models and solve these
M&T - Math	*Math B2 Newton*
	work with elementary properties of integrals and calculate integrals using different techniques for functions of 1 variable
	work with power series and Taylor series, for functions of 1 variable
	solve linear differential equations
	work with complex numbers
BA	*Operation Strategy*
	has knowledge of and insight in the basic principles of production management such as the relationship between company strategy, operations strategy and design of the production system
	can analyze and solve (simple) problems in a production process
	has knowledge of and insight in the main principles of planning and controlling the production process and the role of quantitative modeling as support tool;
Skills	*Academic and management skills*
	Applies the principles of self-reflection, such as the Korthagen reflection cycle and the STARR method in a written self-reflection
	Is aware of his/her own Kolb learning style and can interpret this in relation to the different educational methods within the TOM educational system
	Is able to critically read and evaluate a text and write a brief critique.
	Is able to apply a clear argumentation scheme as a basis to write a brief essay
	Has insight in own interests and motivations to enroll in the IEM program (based on an interview with an alumnus).
	Management skills
	Understands its own Belbin team-role and can reflect on its own functioning within a project team
	Is able to apply basic communication skills (listening, summarizing, direct questioning) during an interview with an alumnus
	Is able to provide constructive peer feedback, e.g. on group performance.

Module 2	weight	EC
Operations Research	25	3
Operations Strategy	25	3
Mathematics *	25	3
Skills	0	2
Project	25	4
Total	100	15

*** results ≥ 5.5 remain valid**

Module 3: Business Intelligence and IT

M3	**Bossiness Intelligence and Information Technology (ism BIT)**
FEM	*Key performance Indicators*
	is able to recognize critical process indicators and is able to apply these indicators in a business situation
	is able to understand the difficulties of using the multi-criteria business control concept (balance scorecard) and to apply this concept in a relatively simple business situation
ITM	***Database Systems & Business Intelligence***
	Can design data models, database schemas, and SQL queries
	Understands and can apply data management and web related technologies (e.g. MySQL)
	Has hands-on knowledge on how to design, access and use a database for Web based applications
	Business Intelligence
	Can *explain* the need for computerized support of managerial decision making
	Can *explain* the business intelligence (BI) methodology and concepts and can explain how they are to be used in combination with decision support systems (DSS) during decision making processes.
	Can *apply* the basic definitions and concepts of data warehouses when asked to design a simple BI software application (i.e., a BI dashboard).
	Can *evaluate and compare* the different types of data warehousing architectures.
	Can explain the process of developing and managing data warehouses and collecting data for business intelligence applications.
	Can *analyze* the all-encompassing nature of performance management (BPM) and apply some of the best practices in planning and management reporting.
	Can evaluate the objectives and benefits of business analytics and data mining, *recognize* the wide range of applications of data mining, and *apply* some of these techniques in relatively simple concrete problems.
	Can *apply, compare and evaluate* the theoretical knowledge of BI in *designing and implementing* BI applications.
	Business Process Management & Enterprise Architecture
	Can *explain* and *relate* concepts, modelling languages, methods, techniques, and tools related to enterprise architecture, business processes and workflow management.
	Can *explain* the design/architecture, functionality and usage of process-aware information systems.
	Can *apply* the above mentioned concepts in *solving* relatively simple business problems.
	Can *design* and *automate* a process model starting from an informal description of a business problem.
	Can *analyze* an enterprise architecture/workflow/process (validation, verification, and performance analysis).
M&T- S&P	*Eenvoudige statistische technieken toetsen en betrouwbaarheidsintervallen*
	Kan eenvoudige statistische technieken toepassen om te onderzoeken of data normaal of exponentieel verdeeld zijn en data samen te vatten en te presenteren
	Kan eenvoudige toetsen en betrouwbaarheidsintervallen toepassen, met betrekking tot het geval van 1 steekproef en het vergelijken van 2 steekproeven
M&T-Meth	*Creativity and design techniques and evaluate and analyze a design process*
	is able to do a bibliographic search, in particular the formulation of search topics and the utilization of databases
	recognize the consequences of plagiarism and be able to reference properly
	recognize the phases of the research cycle and the choices to be made in each phase, and be able to structure a research task in terms of these phases and choices
	know and be able to apply several research techniques, such as experimentation, case study, and think-aloud method
	is able to apply several research techniques, such as experimentation, case study, and think-aloud method
BA	***process of strategy formulation and KPI's***
	The student understands the process of strategy formulation and can apply its basic principles on a case (identify mission/vision, conduct a brief SWOT analysis, and formulate strategy
	The student understands how strategy is transformed into key performance indicators (KPI) and can apply this on a case by formulating SMART goals
	The student knows the main theories about motivation, such as the psychological contract, behavior modification, needs theories, process theories of motivation
	The student understands the human considerations relating to methods for performance measurement and control, and can reflect on these methods in practical situations (e.g. project work, committees or jobs)
Skills	***Academic and professional skills***
	Professional
	is able to deliver basic communication skills in order to deliver a brief presentation (e.g. on project results) for a group of peers and lecturers. The presentation shows basic skills in structure, content, clarity, pose and use of media
	contributes to a clearly structured group report, based on a sound and proper argumentation scheme
	can identify the stages of team development processes by describing its main characteristics and challenges (forming, storming, norming, performing, adjourning) of the project work in Module 2
	contributes to developing a 'group contract' which addresses issues which determine group dynamics, such as shared expectations and efforts, roles and responsibilities, communication, meeting commitments

	Is able to reflect on a personal experience using motivational theories and is aware of his or her abilities to motivate others.
	Is able to systematically argue for and against a certain position on an ethical topic

Module 3	weight	EC
Databases/ Business Intelligence Enterprise Architecture	15	2
Enterprise Architecture / Business Process Management	15	2
Statistics & Probability	20	4
Methodology	10	2
Skills	0	1
Project	40	4
Total	100	15

Module 4: Supply Chain Management

PLM	***Demand and supply chain/ Inventory Management***
	choose the most appropriate techniques for the short-term demand forecasting and apply it
	plan the various activities, e.g., production rate, workforce, overtime, machine capacity, and inventories in a supply chain on an aggregate level using quantitative models
	explain the coordination of the sales including promotions and the operations in a supply chain using quantitative models
	Inventory Management
	classify the various types of inventories, apply the appropriate quantitative models for inventory management in a single-site single-item setting, and analyze the impact of key input variables (cost factors, lead time, demand and service levels) on the inventory policy
	explain at a conceptual level how the inventory management for the multiple items in a single-site setting, as well as for a single-item in the multiple sites setting are interrelated. This includes the bullwhip effect and the impact of information distortion on the performance of a supply chain
	Sourcing/Supply Chain and Network Design/Transport
	explain and illustrate the purchasing function from various angles
	make well-founded decisions on procurement issues such as conducting a portfolio analysis, carrying out a spend analysis, developing a purchasing strategy, and selecting a suitable supplier
	Supply Chain and network design
	Identify the key factors in the distribution network design and discuss the strengths and weaknesses of various distribution options
	design a distribution network using quantitative models
	Transportation
	explain the role of transportation in a supply chain and choose the appropriate transportation mode based on its pros and cons
	formulate and solve the vehicle routing problem and the travelling salesman problem in a single source multiple destinations case using heuristic methods
	Business Game
	select a strategy for the supply chain management
	integrate and apply the different quantitative and qualitative models on sales, operations, inventories, and sourcing, that are needed for the execution of a chosen strategy
	assess and evaluate the performance of a supply chain strategy using quantitative indicators (ROI)
M&T - Math	*Riemann*
	compute partial derivatives and apply them in the context of: curve parameterization and tangent vector, chain rule, directional derivatives, gradient, linearization, Taylor polynomials, absolute extremes, and Lagrange multipliers method
	define and evaluate double and triple integrals over bounded regions and apply them in the context of: iterated integration, area, volume and mass calculations, and polar, cylindrical and spherical substitutions
M&T - S&P	*stochastic inventory control*
	apply the convolutions of continuous random variables and the conditional expectations/variances in order to solve an elementary problem in stochastic inventory control
	apply regression theory to investigate dependence between variables in a relatively simple data set
Skills	*Academic and professional skills*
	understand the challenges that are related to working in cross-functional teams and can reflect on his/her role as a member of a cross-functional team (e.g. during the module's project)
	aware of his/her own personality traits and how this affects his/her leadership style
	identify group decision making models (rational, administrative, political, garbage can), and apply these to project work
	identify own and others decision maker's style (autocratci, information seeking, consulting, negotiating, delegating), and can identify decsion making bias
	understands sources of power to influence others, and can identify influence tactics that they use themselves
	shows basic presentation skills in order to deliver a brief presentation (e.g. on project results) for a group of peers and lecturers/tutors

Module 4	weight	EC
Demand and supply planning and coordination (DSP) in supply chain	20	3
Sourcing decisions/Supply chain network design/Planning Transportation Networks	20	3
Statistics	20	3
Mathematics *	20	3
Skills	0	0
Project	20	3
Total	100	15

*** results ≥ 5.5 remain valid**

Module 5: Financial Engineering

FEM	***Valuation:*** *the student has knowledge is able to or describe the main principles of financial valuation, and is able to apply valuation techniques in determining the value of bond, shares, firms as well as simple financial options. These principles and techniques are:*
	a. The concept of Net Present Value (NPV), and its computation by Discounted Cash Flows (DCF) for a variety of cash flow patterns
	b. The role of diversification in valuation, as addressed in the standard portfolio models of risk-return tradeoffs (Capital Asset Pricing Model, Arbitrage Pricing Theory), and the corresponding computational techniques.
	c. The first principles of option pricing in an elementary setting of binomial trees, and their application to simple options and futures contracts.
	Accounting/performance: *the student is able to interpret real world financial figures related to (external) financial accounting and (internal) management accounting. This concerns:*
	a company's annual report, in particular the financial statements (balance sheet, profit-loss, cash flow statement), and relate it to the valuation principles involved
	b. financial ratios as performance indicators
	c. the role of cost allocation in performance indicators; activity-based costing and direct costing at elementary level
	Decisions/management: *the student has knowledge of is able to apply the principles underlying financial and investment decisions, is able to apply these in actual situations, and is able to reflect on this, with an eye for their limitations. The following aspects are covered:*
	a. The effect of financial decisions, in particular dividend and debt policy, on the value of a firm (Modigliani-Miller theory, tradeoff theory, pecking order theory)
	b. The NPV rule for investment decisions, including the incorporation of tax-effects in the Weighted Average Cost of Capital (WACC) or Adjusted Present Value.
	c. Formulation of financial goals, with attention for their congruence and the concept of affordable growth.
	d. Working capital management
	Financial markets*: the student has is able to describe elementary knowledge of financial markets and can explain their role in corporate finance. This involves the following aspects:*
	a. organization of markets, regulation, supervision, role of AFM
	b. role of financial markets as catalyst and benchmark; concept of market efficiency
	c. financial products: shares, bonds, some derivatives (futures, put-and call options)
M&T - Meth	*Technical and behavioural aspects of (group) decision making in complex organizational contexts*
	Is able to analyze technical and behavioural aspects of (group) decision making in complex organizational contexts, and is able to evaluate such decisions from a decision theory (not content) perspective
	Is able to assess the pros and cons of data gathering techniques (literature study, analysis primary sources, observation, communicative approach) and to motivate the choice of data gathering techniques in own research
	Is able to explain and apply the communicative approach: make interview and survey questions
Skills	*Academic and professional skills*
	The student is able to deliver a pitch (e.g. on project results) for a group of peers and lecturers. The pitch shows advanced presenting skills in delivering a clear and convincing message in 2 minutes.
	The student is able to identify an own identified learning need, take action on it and to reflect on this learning activity.
	The student is able to critically reflect on the use of concepts to make sense of the world, and is able to make a deliberate choice for or against the use of certain conceptualizations in a specific context.

Module 5	weight	EC
Accounting & Finance	25	3,5
Option Pricing	15	2,5
Methodology	15	2,5
Skills	0	1
Project	45	5,5
Total	100	15

Module 6: Consumer Products (under construction)

PLM	***Productie (incl project)***
	The student can recognise and describe the various production processes;
	The student can recognise and interprete (dis) similarities between the various production processes
	The student can relate the (applicability of) production processes to material behaviour.
	The student can relate product geometry, material behaviour, production processes and a.o. production volume, tolerances, accuracy, quality and cost
	The student can select suitable production processes for a given one-fold product design; the student can also adequately substantiate the selection.
	The student has basic competencies in the operation of specified machine tools, subject to the safety regulations for those tools.
	Apply a multi-disciplinary approach to product development problems.
	Re-formulate the problem specification by a client (formulate the 'real' assignment).
	Integrate and employ knowledge from different fields of expertise (like marketing, styling, CAD/CAM, intellectual property, packaging, production, research methodology, etc.)
	Align different phases and perspectives on the product development cycle in respect to the cycle as a whole.
	Technical Product Modeling for IEM
	describe development processes and development phases in an interrelated manner
	describe and apply different methods and techniques (curves, surfaces and solids) that are used in CAD/CAM systems
	describe possible ways to exchange data between different software tools (CAD, analysis, manufacturing) and select appropriate methods
	describe and apply rendering techniques
	describe and apply modern methods and techniques in technical product modelling
	apply feature based modelling techniques and employ them to make doubly curved surfaces
	build large assemblies in such a way that they can easily be adapted (e.g. in case of re-design)
BA	***Sustainable business development***
	Under construction
	Under construction
Skills	***Academic and professional skills***
	Select and set priorities in a plethora of relevant design aspects.
	Integrate and employ knowledge from different fields of expertise (like marketing, styling, CAD/ CAM, intellectual property, packaging, production, research methodology, etc.).
	Align different phases and perspectives on the product development cycle in respect to the cycle as a whole
	Socratic conversation techniques
	Professional
	Apply a multidisciplinary approach.
	Works in an interdisciplinary team and reflects on the consequences of multi disciplinarity on team cooperation and performance
	Present and market a product in an appropriate way.
	Concurrently pay attention to subject-matters and organizational aspects (project planning and management)

Module 6	weight	EC
Technical product modeling	17	2,5
Production 1	17	2,5
Sustainability	13	2,5
Skills	0	0
Project	53	7,5
Total	100	15

M7 From Product Design to Online Business

PLM	*Supply chain management* *• Students will apply cross functional and supply chain integration to design a digital business that aims to deliver customizable products/services to markets using digital channels in a sustainable way*
	Understand the definitions and various associated assessments of product and supply chain sustainability
	Design distribution, operations and production using quantitative models to ensure scalability, flexibility and reliability. Have a high level idea about the impact of returns on a business
	Apply business analytics and performance management to monitor and forecast business performance
	Understand sourcing strategies and various contracting arrangements between the company and its suppliers
FEM	*• Students demonstrate that they are able to use new ICT technology to devise strategy, design online sales, production, E-marketing and finance in their business project*
	Be able to model the financial components of a business model
	Design the financial function of an online business
	Model cash flows and create and implement a realistic financial model
	Understand and design a scalable financial structure for a business
ITM	Key concepts to setup and use modern Enterprise Resource Planning Systems • Students will apply cross functional and supply chain integration to design a digital business that aims to deliver customizable products/services to markets using digital channels in a sustainable way • Students demonstrate that they are able to use new ICT technology to devise strategy, design online sales, production, E-marketing and finance in their business project • Students will design an business-ICT architecture and develop and customize an Enterprise Resource Systems (ERP) to support and integrate the business functions of their business project, and also will be able to see the complexities and limitations of these systems
	Master the key concepts and being able to setup and use modern Enterprise Resource Planning Systems, understand their benefits and challenges
	Analyze the matching and fitting trade-offs of ERPs to Business processes
	Understand Security threats and risk analysis for online business
	Being able to design and evaluate a business-IT architecture for an enterprise, balancing security and openness
	Be able to understand and design Business & ICT Architecture for E-business
	Understand the State-of-the-art ICT for supply chain integration
	Be able to use ERP systems in the context of a small but innovative online business
	Use several ICT tools to support the business design and innovation process including business canvas modelling tools, Group decision support systems, project management tooling, Reasoning tools, Architecture modelling suite, presentation and collaboration tools
M&T-Math	*C1 Cayley Riemann*
	work with systems of linear equations, vectors, matrices, linear transformations and explain the connections between these concepts
	work with determinants, eigenvalues, eigenvectors, linear transformations and connect them with the previous concepts.
M&T-Meth	*Analysis of decision making and decision (design) process* *• Students will be able to apply a design science/lean start-up approach and use an online business as a research living lab*
	Analyse, evaluate a complex decision and design process
	Will be able to evaluate complex organizational decision-making: i.e. leadership, Groupthink
	Will be able to conduct an analysis of a complex decision process
	Conduct a critical analysis of a design process
BA	*Strategy & Bussiness modeling*
	Be familiar with successful examples of online businesses that bring customizable products to the market using online channels
	Understand the most important concepts of strategy and business model design and their evolution
	Understand Agile business innovation and project management principles
	Be able to design a strategy and business model and understanding their evolution
	Be familiar with ICT tools that support business modelling, group decision making
	E-marketing *• Students demonstrate that they are able to use new ICT technology to devise strategy, design online sales, production, E-marketing and finance in their business project*
	Understand the impact of internet and online channels on marketing principles
	Understand E-marketing principles and applications
	Understanding and applying new ways of product and service marketing, including the use of social media, search engine optimization and crowd sourcing
	Know the various digital channels, advertising models, and digital marketing concepts and their recent developments
	Be able to design a digital marketing plan and implement it using E-marketing technologies
	Product, Service and CSR *• Students implement legal, societal, sustainability and Corporate Social Repsonsibility frames that apply to modern and global business in their business design*

	Understand the product, service, servitization, customization concepts
	Understand the potential of new prototyping production technologies such as 3D printing, laser cutting
	Understand key concepts of Corporate Social Responsibility and the associated trade-offs
	Value the roles of various user/stakeholders in business decisions
	Understand the role of ethics in business
	Make informed choices about the sustainability of sourcing, staffing and production
	Be familiar with ICT tools for product customization and service design
	Legal aspects *• Students implement legal, societal, sustainability and Corporate Social Responsibility frames that apply to modern and global business in their business design*
	Having knowledge of contracting, patents, liabilities, risk, privacy and consumer and business rights
	Design a basic legal structure for a company with digital presence and potentially global sourcing of components
Skills	*Academic and professional skills*
	The student is able to write a clear and structured essay. (Academic skills)
	The student is able to do a pitch to convince the audience of the relevance of the message, and to deliver this message through a short presentation of about 2-3 minutes with limited use of media (Academic skills/management skill)
	The student can reflect on the role as a project manager of the project team for a period of approximately 2 to 3 weeks, thereby showing 'performance' competences and 'personal' competences to meet the project's deliverables and meets stakeholders expectations. Performance competences demonstrate ability to manage project-related activities and achieve the intended outcomes. Personal competences demonstrate the managerial behaviors when performing project management tasks. (Management skills)
	The student is able to identify an own identified learning need, take action on it and to reflect on this learning activity.

Module 7	weight	EC
Product Design to Online Business Theory	25	4
Mathematics *	25	3
Skills	0	0,5
Project	50	7,5
Total	100	15

*** results ≥ 5.5 remain valid**

Module 8: MODELLING AND ANALYSIS OF STOCHASTIC PROCESSES FOR IEM (201400062)

4 LEARNING OBJECTIVES

The module contains three blocks, namely (i) stochastic models (Markov chains, queueing theory, stochastic dynamic programming, and project stochastic models), (ii) simulation and heuristics (discrete event simulation, heuristics, and project simulation and heuristics), and (iii) the multidisciplinary project. The learning objectives per block are:

1. Stochastic models. After successful completion of this part, the student is able to:
    a. *formulate* a Markov chain model for a given problem description and *solve* this model;
    b. *formulate* a Stochastic Dynamic Programming (SDP) model for a given problem description and *solve* this model;
    c. *formulate* a Markov Decision Process (MDP) model for a given problem description and *solve* this model;
    d. *interpret* the outcomes of a SDP and MDP model in order to construct an optimal strategy, which is applicable in a given practical situation;
    e. *select* an appropriate queuing model (M/M/1, M/M/c, etc.) for a given problem description and *solve* this model;
    f. *interpret* the implications of a queueing system's performance on (given) performance indicators and *formulate* practical recommendations for system improvement;
    g. *select* appropriate models and methods (from those provided in the Stochastic models part) that are relevant to a given problem, and *use* them to *draw* conclusions about the behaviour of the system.
2. Simulation and heuristics. After successful completion of this part, the student is able to:
    a. *describe* the different types of simulation, their applicability, and how to setup a simulation study;
    b. *understands* the core principles of discrete event simulation (e.g., the event controller, random numbers, and warm-up period);
    c. *design* and *implement* a conceptual simulation model in a simulation environment, according to the project specifications;
    d. *define* input for a simulation model (e.g., different statistical distributions) and *design* experiments (e.g., combination of experimental factors, ranges, performance indicators);
    e. *perform* simulation experiments, *interpret* the outcomes of the simulation, and *formulate* recommendations that are useful for the problem owner;
    f. *explain* the concepts of (i) construction and improvement heuristics and (ii) local search heuristics;
    g. *apply* construction and improvement heuristics and local search heuristics to solve relatively simple problems.
3. Multidisciplinary project. After successful completion of this part, the student is able to:
    a. *communicate* and *collaborate* with students of different educational backgrounds;
    b. *select* appropriate modelling tools (from the set of tools provided in this module) for a large real-life problem, and use them to *model* and *solve* the problem.
    c. *interpret* the outcomes of the before mentioned tools and *formulate* practical recommendations for system improvement;
    d. *inform* and *convince* the problem owner by means of a report and presentation.

This module contributes to the following professional exit qualifications of the IEM bachelor program: A1, A3, A4, A6, A7, B1, B2, B3, B6, B7, and B8.

Module 8	weight	EC
Stochastics Models Theory and Project Stochastic Models	43	6,5
Simulation and Heuristics Theory and Simulation and Heuristics Project	44	6,5
Multi - disciplinary Project	13	2
Total	100	15

Module 11: Preparation BSc Thesis

M11	Thesis preparation
	Plan of approach for BSc Thesis
M&T-Meth	*Methodology*
	Activate and integrate prior learning, e.g. about MSPM and literature search
	Work, based on having an overview about the general research approach (core problem, problem definition, research question, theoretical model or perspective, research method
	Transform practical problem into a specific research question and sub-questions
	Perform literature review, integrates theoretical perspectives and theories
	Make research design, aligned with research question and feasible
	Understand qualitative and quantitative analysis methods and can choose methods
	Understand creative problem solving and can choose method
	Choose decision support methods
	Describe how to integrate research results into solutions for action problems
	Act in a complex social environment with different stakeholders, meeting university requirements, with prior learning as foundation
	Know what the basic features of being scientific are
	Apply nrs 3 through 7 in a well-founded, internally consistent and reproducible way to situate and evaluate own practices (project plan)
	Judge when and how to be scientific, e.g. in setting priorities, and knows that 'what is scientific' depends on context and sometimes is disputed
	Assess whether (s)he actually learns what (s)he needs
	Convert information into a learning experience
	Write a project plan, meeting predefined criteria and (formal) requirements of referencing, quoting, prevention of plagiarism/fraud, structure, argumentation, style and design
	Apply data analysis method(s)
	Select and apply a creative problem solving method
BA	*Ethics*
	Recognize and describe ethical dilemmas in their field and develop reasoned decisions
	Identify values at stake and relate these to role and responsibility
	Reflect on his/her competences and behavior
	Apply principles and concepts of professional responsibility and ethics
	Know key ethical theories and can apply them to cases
	Is aware that design choices in an organization influence the ability of others to take responsibility
Skills	*Academic skills*
	integrate research methodology components into an overall framework and approach
	integrate different skills into a repertoire
	integrate ethics, professional responsibility and philosophy of science in the project plan
	demonstrate critical thinking
	demonstrate critical reading of academic literature
	design and present an academic poster and attracts feedback and potential supervisors
	make a detailed and realistic project plan
	is capable of managing the proposed project (after M11)
	identify own learning needs
	manage own learning process
	discriminate main from side issues
	speak effectively, in a structured and understandable way
	listen critically and effectively, e.g. in interviews
	engage in a meaningful discussion
	write an academic literature review

Module 11	weight	EC
Philosophy of science, professional responsibility and business ethics *	20	5
Skills (portfolio)	20	2
Project Plan and methodology	60	8
Total	100	15

Module 12: Thesis

M12	Thesis
	can formulate the chosen research or design assignment in terms of a related problem definition, including research/design questions, and develop a plan of action for the implementation of his/her approach
	uses concepts and theories within his/her own field, identifying links with recent developments in the field
	explains and justifies the choices made, where applicable
	presents research/design results and relates these to the problem definition and the research/design questions
	presents/describes the socio-cultural, scientific or ethical issues that are relevant to these results
	presents his/her research in a clear, structured manner that is comprehensible to an audience of varying educational levels and backgrounds
	writes a critical reflection on his/her own professional conduct
	writes a critical reflection on his/her own professional conduct
	works autonomously, under supervision, in relation to the preparation and implementation of the assignment

Module 12	weight	EC
Graduation Project	100	15
Total	100	15