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Course of Study-Specific Examination Regulations

for the Master's Course of Study in

Construction and Robotics

at RWTH Aachen University

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Now Issued in Their Fourth Revised Version

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Published as a Complete Version

Please note: This publication is an English translation. Only the German original of these regulations as published in the Official Announcements of RWTH Aachen University ("Amtliche Bekanntmachungen") is legally binding.

Based on §§ 2 (4) and 64 of the Higher Education Act of the State of North Rhine-Westphalia (Hochschulgesetz – HG) in the version of the announcement dated September 16, 2014 (Law and Official Gazette of the State of North Rhine-Westphalia p. 547), most recently amended by Article 1 of the Act on Membership of University Hospitals in the Employers' Association of North Rhine-Westphalia, dated June 30, 2022 (GV. NRW p.780b), RWTH Aachen University (RWTH) has issued the following regulations:

ISSUED BY DIVISION 1.1 OF DEPARTMENT 1.0 ON BEHALF OF THE RECTOR OF RWTH AACHEN UNIVERSITY
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I. General

§ 1
Scope of Application and Academic Degree

(1) These regulations apply to the master's course of study in Construction and Robotics at RWTH. They only apply in conjunction with the currently valid version of the General Examination Regulations (GER) in the relevant applicable version, supplementing it with an additional set of course of study-specific regulations. In cases of doubt, the provisions of the General Examination Regulations take precedence.

(2) Students who successfully complete the master's course of study are awarded the academic degree of Master of Science RWTH Aachen University (M. Sc. RWTH) by the Faculty of Architecture.

§ 2
Objectives of the Course of Study and Language Provisions

(1) This master's program builds on the bachelor's programs in architecture, civil engineering, mechanical engineering, and computer science in accordance with § 2 (3) GER.

(2) The overall educational objectives are set out in § 2 (1, 3, 4) GER. Regulations on the objectives of the Master's course of study are stipulated in Appendix 1.

(3) The course of study is taught in English. Insofar as individual modules are taught in another language, this is to be indicated in the module catalog.

(4) In agreement with the relevant examiner, exams may be taken in English or German.

§ 3
Admission Requirements

(1) An essential requirement for admission is a recognized first university degree according to § 3 (4) GER.

(2) To meet the subject-specific requirements and successfully complete the Construction and Robotics master's course of study, the applicant must provide evidence of the required skills and knowledge. The skills and knowledge must be comparable to those taught in the following bachelor's programs at RWTH Aachen University:

a. Computer Science
b. Architecture
c. Civil Engineering
d. Mechanical Engineering

Depending on the candidate's discipline, which will be determined based on their prior qualifications, applicants must demonstrate knowledge from the following areas and to the extent specified in order to be admitted to the Construction and Robotics master's course:

a) For the discipline of Computer Science, evidence of 62 CP is required, awarded for assessments comparable to those required by the basic modules of the RWTH bachelor's program in Computer Science:

Area	Module	CP
Applied Computer Science	Programming	22
	Data Structures and Algorithms	
	Software Engineering	
	Databases and Information Systems	
Computer Engineering	Introduction to Computer Engineering	14
	Operating Systems and Systems Software	
	Data Communication and Security	
Theoretical Computer Science	Formal Systems, Automata, and Processes	6
Mathematics	Analysis for Computer Scientists	14
	Linear Algebra	
Other requirements	Software Lab Course	6

b) For the discipline of Architecture, evidence of 92 CP is required, earned for knowledge and skills comparable to those taught in the basic modules of the RWTH bachelor's program in Architecture:

Area	Module	CP
Cultural and Historical Basics	Cultural and Historical Basics I - IV	12
Design and Presentation	Design and Presentation I - II	12
Digital Construction Processes and Methods	Digital Construction Processes and Methods	6
Construction and Design	Building Construction and Building Materials	12
	Building Construction II	
	Building Technology I	8
	Building Technology II	
	Integrated Project Architecture and Construction	10
Structures	Structures I	8
	Structures II	
Building Planning and Design	Designing	18
Basics of Design	Basics of Design	6

In addition, applicants must provide evidence of 6 CP earned in the area of digital architecture. The learning content and educational objectives are software- and programming-based and can be summarized as follows:

Visual Programming:

- Modeling and editing of graphics algorithms and fundamentals of algorithmic problem solving
- Introduction to visual programming with Grasshopper, Dynamo, or similar tools

Computer-Aided Design and Engineering

- Basic understanding of 3D modeling, technical illustration, and 2D drawing. In particular:
  - Creation and editing of polygon curves,
  - NURBS curves and surfaces,
  - Subdivision and meshes,
  - Volume bodies,
  - Point clouds, and
  - Polygon meshes.
- Basic techniques of visualization and animation

Building Information Modeling

- Fundamental knowledge, introduction to object-oriented modeling of components with attribution, generation of subject-specific representations such as views, sections, and floor plans of the information model, simple visualizations of the entire building with rendering and animation

c) For the discipline of civil engineering, evidence of 89 CP is required, awarded for assessments comparable to those required by the following basic modules of the RWTH bachelor's program in Civil Engineering

Area	Module	CP
Fundamentals of Mathematics	Mathematics I - II	16
	Applied Statistics	3
Mechanics	Mechanics I - II	16
Fundamentals of Engineering and Civil Engineering	Building Materials Science	8
	Building Physics	3
	Building Construction II	5
	Structural Concrete I	4
	Construction Informatics	3
	Structural Analysis I	5
	Project Management I / Construction Contract Law I	4
	Geotechnical Engineering I	5
	Planning Methodology	4
	Construction Methods I	3

	Urban and Regional Planning	3
	Lifecycle of Construction Projects – Preparation and Implementation	4
Digital Construction	Introduction to CAD	3

d) For the discipline of Mechanical Engineering, 88 credit points from the fields of engineering, mathematics and natural sciences (excluding practical work experience) are required, awarded for assessments comparable to those required by the following basic modules of the RWTH bachelor's program in mechanical engineering:

Area	Module	CP
Mechanics Resistance of Materials Statics Dynamics	Mechanics I	18
	Mechanics II	
	Mechanics III	
Machine Design/ Machine Elements	Machine Design I and Introduction to CAD	13
	Machine Design I	
	Machine Design IIII	
Thermodynamics	Thermodynamics I	7
	Thermodynamics II	
Heat and Mass Transfer	Heat and Mass Transfer I	6
Materials Science	Materials Science I	10
	Materials Science II	
Automatic Control	Automatic Control	6
Fluid Mechanics	Fluid Mechanics I	6
Mathematics	Mathematics I	17
	Mathematics II	
	Mathematics III	
Computer Science	Computer Science in Mechanical Engineering	5

(3) For admission conditional on the completion of additional requirements, § 3 (6) GER applies. If additional requirements corresponding to more than 12 credit points are imposed, admission to the master’s course of study will be denied.

Admission to the master's course of study is also denied if the additional requirements include:

a) the Software Lab (Computer Science)
b) components from the areas of "Digital Construction Processes and Methods" or "Structural Engineering" or "Digital Architecture" (Architecture)
c) the modules "Building Informatics" or "Building Materials Science" or components in the areas of "Mechanics" or "Digital Construction" (Civil Engineering).
d) components from the area of Computer Science (Mechanical Engineering)

(4) For this master's course of study, students must prove they are proficient in English according to § 3 (9) GER.

(5) If admission is dependent on the completion of additional requirements and one or more of these requirements can only be completed in German, then, in addition to the language skills outlined in paragraph 4, the candidate must also prove they are proficient in German pursuant to § 3 (7a) GER.

(6) Furthermore, candidates must provide evidence of professional work experience/the completion of internships in accordance with the Guidelines for Practical Professional Experience. These guidelines are included in these examination regulations (Appendix 3). Evidence of practical work experience must be submitted by the time of admission to the master's thesis at the latest.

(7) § 3 (12) GER applies for determining whether the candidate meets the admission requirements

(8) General regulations on the recognition of prior exams and assessments are stipulated in § 13 GER.

§ 4 Standard Period of Study, Curriculum, Credit Points, and Scope of Study

(1) The standard period of study, including the completion of the master's thesis, is four semesters (two years) full-time. Students can start their studies in the winter semester or the summer semester.

(2) Admitted candidates will be assigned to one of the following disciplines by the Examination Board, depending on their prior subject-specific qualifications:

a. Mechanical Engineering
b. Architecture
c. Civil Engineering
d. Computer Science

The discipline to which the successful applicant has been assigned will be communicated in the letter of admission.

(3) The course of study consists of a mandatory section, a core elective section, three projects, and the master's thesis.
For successful completion of the degree program, a total of 120 credit points must be earned. The master's examination is comprised of the following components:

Mandatory modules	10 CP
Core elective modules	35 CP

Projects	45 CP
Master's Thesis	30 CP
Total	120 CP

(4) The degree program, including the master's thesis module, is comprised of 15 to 19 modules. All modules are specified in the module catalog. The assignments or exams to be completed in the individual modules (with credit points) are weighted according to § 4 (4) GER.

(5) A total of 18 CP must be acquired in the core elective section "Basics of Other Disciplines". Students must earn at least 3 CP in all disciplines except their own discipline.

§ 5
Obligatory Attendance in Classes

(1) According to § 5 (2) GER, obligatory attendance can only be stipulated in the following course types:

1. Tutorials
2. Seminars and introductory seminars ("Proseminare")
3. Colloquia
4. Lab courses
5. Excursions

(2) Classes for which attendance is required in accordance with paragraph 1 shall be identified as such in the module catalog.

§ 6
Exams and Exam Deadlines

(1) General regulations on exams and exam periods are stipulated in § 6 GER.

(2) If successful completion of modules, exams, or module components according to § 5 (4) GER is stipulated as a precondition for participation in other exams, this is indicated in the module catalog.

§ 7
Types of Exams

(1) General regulations on types of exams are stipulated in § 7 GER.

(2) The following other forms of exams are stipulated according to § 7 (1) GER:

1. **Tutorials concluded with a colloquium** may include: Supervised design assignments on construction or planning tasks, artistic works (including portfolios) or minor academic papers (5 - 20 pages), which are presented and discussed in a colloquium. The duration of the colloquium is a minimum of 15 and a maximum of 30 minutes per candidate.

2. **Tutorials concluded with a written exam** may include: Supervised design tutorials on construction or planning tasks, artistic works (including portfolios) or minor academic papers (5 - 20 pages), completion of which is a prerequisite for participation in a concluding written exam. The assignments contribute to the overall grade.

3. Creating a **portfolio**, students work on a task on the subject matter of the course during the semester under supervision, developing and completing it independently using suitable aids and tools in accordance with the instructions. The scope of work to be carried out for the portfolio shall be announced at the beginning of the course.

(3) The duration of a **written** exam is as follows:

- 60 to 90 minutes for up to 5 CP
- 90 to 120 minutes for 6 to 7 CP
- 120+ minutes for 8 or more CP

(4) The duration of an **oral exam** is at least 15 minutes and at most 60 minutes per candidate. An oral exam may be carried out as a group exam with up to six candidates. The duration of a group exam shall be 30 to 90 minutes.

(5) Term papers shall range from 1 to 100 A4 pages. Students are typically given one week to three months to complete a term paper.

(6) The following applies to **project work**: Within projects, students conduct independent academic activities, e.g. complete constructive, functional, or theoretical academic tasks. The work results must be documented in a written paper and presented in a colloquium. Such project work is to train students in selecting and applying suitable project management tools, working in a team, organizing themselves, and coordinating group activities. For the implementation and assessment of colloquia, § 7 (8) of these examination regulations shall apply in conjunction with § 7 (12) GER. As a rule, project work by students is supervised by academic staff. Project work shall be carried out within one semester and is worth 12 credit points. Project activities are carried out in groups of three to five individuals, whereby the concept of the project must allow for grading of each participating student. Exceptions regarding group size are only possible under special circumstances and upon application.

(7) The scope of a written presentation is 1 to 100 pages. The corresponding presentation should be 10 to 60 minutes long.

(8) The following applies to **colloquia**: As a rule, attendance of colloquia should be open to all members of the Faculty. For individually completed project work, the duration of the colloquium is a minimum of 15 and a maximum of 30 minutes per candidate. For group work, the duration of the colloquium is a minimum of 20 and a maximum of 60 minutes. Guest reviewers will be appointed in advance (if applicable). Guest reviewers are experts with outstanding, proven achievements in teaching, research, and/or practice. Upon invitation by the Faculty or by the examiners, they may also take part in the colloquium.

(9) The instructor specifies the duration and, if applicable, other modalities of the exam or assignment at the start of the course.

(10) Admission to module examinations may be conditional on the successful completion of **module components** as examination requirements in accordance with § 7 (15) GER. This is outlined in the module catalog for the relevant modules. At the start of semester, or by the time of the first course session, the lecturer shall provide precise criteria in the CMS regarding possible improvement of grades through the completion of module components, particularly the number and type of components to be completed for extra credit and the mode of correction and assessment.

§ 8
Assessment and Grading

(1) For general regulations on the assessment of exams and the grading process, please refer to §10 GER.

(2) The overall grade is determined by combining all module grades and the grade of the master's thesis according to § 10 (10) GER.

(3) In the event that all module examinations of the master's course have been completed within the standard period of study, one weighted module grade, with the exception of grades for project work, may be cancelled in accordance with § 10 (13) GER.

§ 9
Examination Board

The responsible Examination Board according to § 11 GER is the Examination Board for the Construction and Robotics master's program. The group of the Board's four professorial members consists of one member each from the Faculty of Architecture; the Faculty of Mathematics, Natural Sciences and Computer Science; the Faculty of Mechanical Engineering; and the Faculty of Civil Engineering.
The Examination Board is chaired by the professorial member of the Faculty of Architecture. However it is not possible for the course convenor to act as chair the Examination Board at the same time. The member of the group of academic staff and the two members of the group of students also belong to the Faculty of Architecture.

§ 10
Retaking Exams or Rewriting the Master's Thesis, and Loss of the Right to Take an Exam

(1) General regulations governing retaking exams or rewriting the master's thesis as well as the loss of the right to take exams are stipulated in § 14 GER.

(2) Modules that can be freely selected within the elective area of this Master's course can be replaced upon application to the Examination Board, provided that this is permitted in the module catalog and no assessments or exams have been completed. It is not possible to substitute mandatory modules.

§ 11
Deregistration, Non-Attendance, Withdrawal, Deception, Non-Compliance

(1) General provisions on deregistration, non-attendance, withdrawal, cheating attempts, or non-compliance are stipulated in § 15 GER.

(2) The following applies to the deregistration from lab courses and seminars: deregistration from block courses is possible until one day before the first day of the course.

II. Master's Examination and Master's Thesis

§ 12
Type and Scope of the Master's Examination

(1) The master's examination consists of

1. exams and assessments that are to be completed based on the structure of the course of study according to § 4 (2) and detailed in the module catalog, as well as

2. the master's thesis and the master's final colloquium.

(2) The order in which students shall take the courses is based on the curriculum (Appendix 2). The topic of the master's thesis can be agreed on after completion of 81 credit points and after the student has provided evidence of having completed the mandatory internship.

§ 13
Master's Thesis

(1) General provisions for the master's thesis are stipulated in § 17 GER.

(2) Further details regarding the supervision of the master's thesis are outlined in § 17 (2) GER.

(3) The master's thesis is to be written in English or German.

(4) The time frame for completion of the Master's thesis is usually a minimum of 18 and a maximum of 22 weeks alongside studies. In justified exceptional cases, the writing time/completion period can be extended by a maximum of up to six weeks upon application to the examination board in accordance with § 17 (7) GER.

(5) The candidate shall present the results of their master's thesis in a master's final colloquium which,

as a rule, is open to members of the relevant Faculties. If the master's colloquium is not to be held as outlined above, this must be approved by the Examination Board when applying for admission. § 7 (12) GER in connection with § 7 (11) apply accordingly.

(6) The work required for preparing and writing the master's thesis, including the colloquium, shall correspond to 30 credit points. The master's thesis can only be graded after the master's final colloquium has taken place.

§ 14
Acceptance and Assessment of the Master's Thesis

(1) General provisions on the acceptance and assessment of the master's thesis are stipulated in § 18 GER.

(2) Two copies of the master's thesis, printed and bound, are to be submitted to the Examination Board by the set deadline. Deviations from this procedure must be approved by the Examination Board. The application for approval must be made together with the application for admission to the master's thesis. Additionally, the thesis must be submitted as a PDF file on a data carrier.

III. Final Provisions

§ 15
Viewing of Examination Records

The reviewing of exam documents shall be carried out in accordance with § 22 GER.

§ 16
Entry Into Force, Publication, and Transitional Provisions

(1) These examination regulations are published in the official announcements of RWTH Aachen University (“Amtliche Bekanntmachungen”) and come into effect the day after publication.

(2) These examination regulations apply to all students who are enrolled in the Construction and Robotics master’s course of study at RWTH.

(3) The last time that it is possible to enroll in the Construction and Robotics master's course of study is in the 2023 summer semester.

(4) The courses in the Construction and Robotics master's program will be held for the last time in the 2025/2026 winter semester.

(5) Exams in the Construction and Robotics master's program will be held for the last time in the 2025/2026 winter semester.

(6) Admission to the master's thesis – including rewriting the master's thesis – can be applied for the last time in the 2026 summer semester.

(7) After the end of the 2026/2027 winter semester, graduation from the Construction and Robotics master’s program is no longer possible.

Issued based on the resolution of the Faculty Council of the Faculty of Architecture dated February 15, 2023.

It is pointed out that, in accordance with § 12 (5) NRW HG, any claims regarding a violation of procedural or formal requirements of the regulatory or other autonomous rights of the University may no longer be asserted after one year has elapsed since the official publication of this announcement unless:

1) the announcement has not been properly published,
2) the Rectorate has objected, prior to publication, to the decision of the committee adopting the regulations,
3) the University has been previously notified about the defect of form or procedure in a complaint, specifying the infringed legal provision and the fact that gives rise to the defect, or
4) the legal consequence of the exclusion of complaints was not pointed out in the public announcement.

The Rector
of RWTH Aachen University

Aachen,
dated March 6, 2023,

sgd. Rüdiger

Univ.-Prof. Dr. rer. nat. Dr. h. c. mult. U. Rüdiger

Appendix 1:

Educational Objectives and Taught Competencies of the Construction and Robotics (CR) Course of Study

CR is an interdisciplinary and international Master of Science program that draws on the disciplines of the Faculties of Computer Science, Architecture, Civil Engineering, and Mechanical Engineering. CR is the first RWTH program concerned with digitalization of the construction industry. It is also the first of its kind among the TU9 and the IDEA league universities. Although there are already some degree programs that focus on the deployment of robots and automation, it is the first program of its kind for the field of construction. In other programs, the use of robots in architecture is usually limited to design and shaping. RWTH CR, by contrast, looks at the entire process that is required to close the digital gap in this sector.

Graduates of the program are highly specialized engineers who will significantly influence future construction processes from structural planning to the construction site through material implementation, production, and manufacturing based on digital and machine-based methods. To this end, the CR program offers high-quality teaching and a focus on interdisciplinary working methods resulting from the involvement of different Faculties.

The program aims to provide students with the following qualifications and competencies:

1. Students are able to identify and analyze complex interdisciplinary problems, break them down into sub-problems, develop solutions, and evaluate them.
2. Students are able to apply the taught methods within interdisciplinary work processes and to moderate group dynamics processes in a solution-oriented way.
3. Students know the relevant scientific methods and can apply them in an informed and effective way.
4. The program enables students to understand the academic discourse of various disciplines and to act as information brokers between the disciplines.
5. The students understand the key processes in the construction industry and are able to identify the potential that digitalization might bring to their sub-processes. They are able to implement these with the help of construction-organizational approaches based on digital planning and production methods.
6. Students acquire expertise to identify key technologies for automation and digitalization and to develop them further.
7. With the skills they have learned, the students have a sound knowledge of various interdisciplinary processes and technologies to address the challenges faced by the construction sector in the area of digitalization. An important role play:
    a. the digitalization of materials and building products, taking into account aspects such as resources and sustainability, and
    b. innovative construction and production methods, with particular focus on future change processes in planning, preproduction, and on construction sites.
8. Through their broad knowledge of the various disciplines involved, the students are able to develop new business models for the construction industry.

The program lasts four semesters and is mainly offered in English. The program has the following structure:

Approximately half of the credit points of the first three semesters are awarded through modules which:

- deepen the students' knowledge in their discipline
- provide a basic understanding of neighboring disciplines, and
- introduce general management methods

This knowledge is applied in various projects conducted alongside studies. Any remaining credits are gained by completing these projects. As part of the project activities, students acquire “digital and soft skills for interdisciplinary research”, i.e. relevant techniques and skills, through supplementary self-study. The students apply the learned methods, skills, and technologies when preparing and writing the master’s thesis.

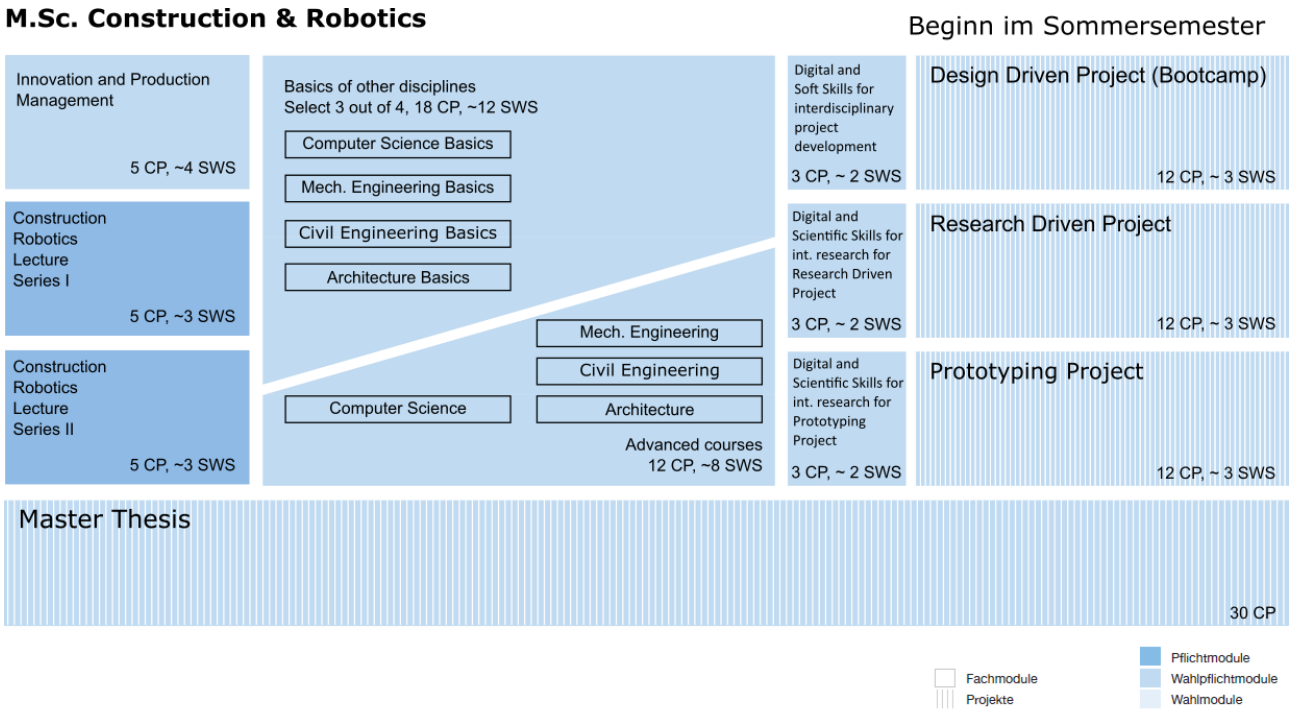
Due to the interdisciplinary and project-focused nature of the curriculum, CR graduates are able to analyze and understand construction processes and determine where digitalization may be successfully employed.

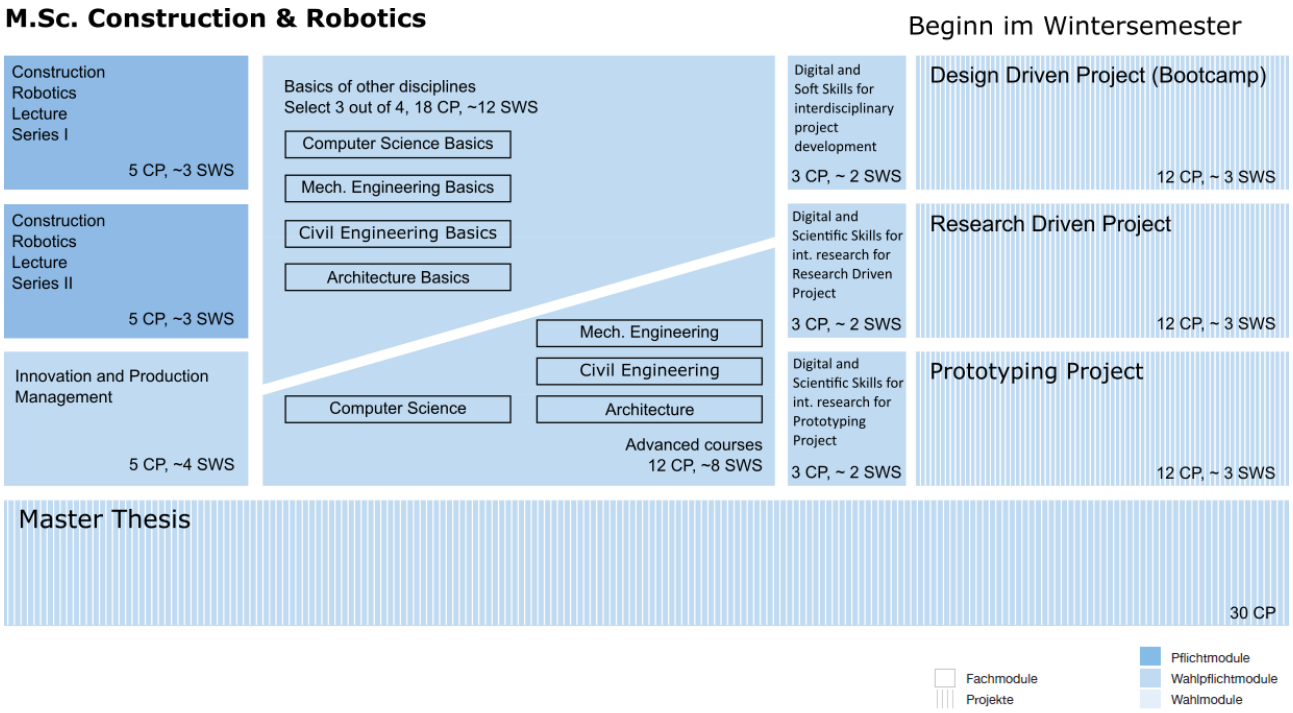
The skills profile opens up highly specialized job roles that complement the spectrum of existing professional roles and are well suited to boost innovation through their structural interdisciplinarity. This results in excellent career prospects. The degree program prepares, in particular, for roles and activities in the following areas:

1. New professional role as a construction production coordinator with core competencies in digital methods
2. Interface management for highly integrated digital work processes along the entire value chain of the construction industry
3. Engineering, planning and consulting agencies with a focus on digitalization
4. Consultants for sustainable construction in the digital age
5. Building contractors
6. Manufacturers of construction machinery and equipment
7. Roles in public administration to develop guidelines for buildings and construction processes at the national and European level or to support developing countries
8. Enterprises with a focus on the preproduction of components for construction sites
9. Enterprises whose main activities concern construction sites
10. Graduates of the CR master’s program are also qualified for fundamental scientific research and application-oriented product development. As research managers, they are able to work at the interface between various disciplines. Graduates have a good understanding of interdisciplinary research and collaboration with researchers from different professional backgrounds.

Appendix 2:

Curriculum





Appendix 3:

Guidelines for Internships/Practical Professional Experience

The internship is intended to complement academic study with practical activities in the field of construction and robotics and to provide students with hands-on professional experience. The internship must be completed in companies related to the construction industry and must meet both of the following criteria:

A - The job involves hands-on construction tasks on site/in prefabrication that provide insight into real-world construction processes.
B - The activity has a focus on digital / automated processes.

Students shall search for suitable internship positions on their own. The internship must be equivalent to a 2-month full-time position; at least 3 weeks at a time must be completed for activities meeting criteria A and B. Internships of less than three weeks in duration are not recognized. It is recommended that the practical work be carried out after completion of the bachelor's degree.

The internship must be completed in a construction company, on a civil engineering construction site, in a construction management agency, in a company with a focus on prefabrication (for buildings and components), or in a crafts enterprise in the construction industry. In addition, the internship can also be completed with construction machinery manufacturers, machine tool manufacturers focusing on the construction industry, and software manufacturers or consultants for construction and planning software in the construction industry. The focus of the activity should be on the digital/automated processes of construction, starting with the overall organization through the site management through processes in pre-fabrication, processes for the technical support of construction processes – including machine and tool design – to the actual construction process.

An informal written internship report must be prepared in English or German, not exceeding 4 A4 pages in length, which provides information about the activities performed. The report must be signed by the intern’s supervisor at the company. At the end of the work placement, the intern receives a certificate from the host company, specifying the duration of the placements in different departments and the number of days absent due to holiday or illness. The internship certificate must be issued by the internship hosting company. Certificates from recruitment agencies will not be accepted.

In order to complete the “Internship in Digitalization & Automation in Civil Engineering” module component, the signed originals of the internship certificate and the internship report have to be submitted before registering the master’s thesis Internship certificates in a language other than English or German must be submitted together with a certified translation into English or German. The original certificate, signed by the supervisor, must be submitted.

The Examination Board decides whether exceptions may be granted and whether internships in related areas may be recognized.