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Course of Study-Specific Examination Regulations

for the Master's Course of Study

in Automotive Engineering

at RWTH Aachen University

Dated September 17, 2020

(Examination Regulations 2020 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 North Rhine-Westphalia (Higher Education Act; Hochschulgesetz – HG) in the version of the act dated September 16, 2014 (Law and Official Gazette of the State of North Rhine-Westphalia; GV. NRW. p. 547), most recently amended by Article 10 of the NRW Act on Containing the COVID-19 Pandemic (Gesetz zur konsequenten und solidarischen Bewältigung der COVID-19-Pandemie in Nordrhein-Westfalen und zur Anpassung des Landesrechts im Hinblick auf die Auswirkungen einer Pandemie) dated April 14, 2020 (GV. NRW, p. 218b, corr. p. 304a), RWTH Aachen University has issued the following regulations:

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Appendices:

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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 Automotive Engineering at RWTH. They only apply in conjunction with the currently valid version of the General Examination Regulations (GER), supplementing it with an additional set of course-specific regulations. In cases of doubt, the provisions of the General Examination Regulations take precedence.

(2) Upon successful completion of the master’s course of study, the academic degree of Master of Science is conferred by RWTH Aachen University (M. Sc. RWTH).

§ 2
Program Objectives and Language of Tuition

(1) This master's degree program builds upon the bachelor's degree program in Mechanical Engineering Science in accordance with § 2 (3) GER.

(2) The overall educational objectives are set out in § 2 (1, 3, 4) GER. The course of study-specific educational objectives are part of the examination regulations description in the module catalog.

(3) The degree program is mainly taught in English. Only a few courses are held in German.

(4) Exams may be taken in German or English, in agreement with the examiner in question.

§ 3
Admission Requirements

(1) A recognized first university degree according to § 3 (4) GER is required to be eligible for admission.

(2) To meet the subject-specific requirements allowing them to successfully complete the master’s course in Automotive Engineering at RWTH Aachen University, applicants must have the necessary knowledge and skills evidenced by credit points (CP) in the following areas:

- A total of 120 CP from the fields of engineering, mathematics and the natural sciences, excluding internships.
- These 120 CP must have been awarded for assessments comparable to those required by the following basic modules of the RWTH bachelor's program in mechanical engineering. A detailed description of the knowledge and skills required can be found in Appendix 4.

Module	CP
Mechanics I	18
Mechanics II	
Mechanics III	
Machine Design I	13
Introduction to CAD	
Machine Design I	
Machine Design IIII	
Thermodynamics I	7
Thermodynamics II	
Heat and Mass Transfer I	6
Materials Science I	8
Materials Science II	
Automatic Control	6
Fluid Mechanics I	6
Mathematics I	17
Mathematics II	
Mathematics III	

- Basic vehicle technology modules from the professional field of traffic engineering-automotive engineering of the bachelor's degree program in mechanical engineering at RWTH Aachen University to the extent listed or comparable credit points:

Module	CP
Automotive Engineering I (Longitudinal Dynamics)	6
Automotive Engineering II (Vertical and Lateral Dynamics)	6
Mobile Propulsion Fundamentals	4
Mechatronic Systems	6

In addition, all applicants must prove they have successfully passed the Graduate Record Examination (GRE) General Test. Applications without GRE will not be considered. In this test, the following point values must be achieved in the individual areas:

Verbal Reasoning: 145 points
Quantitative Reasoning: 160 points
Analytical Writing: 3 points

Applicants who are citizens of a member state of the European Union or of the European Economic Area (EEA) as well as “Bildungsinländerinnen” or “Bildungsinländer”, i.e. non-German citizens who have a German school leaving certificate or university degree, are exempt from this rule.

(3) § 3 (6) GER applies for admission conditional on the completion of additional requirements.

(4) For this master's course of study, English proficiency must be proven according to § 3 (9) GER.

(5) Proof of having completed the necessary internships is also required for admission. Such practical work experience in industry must comprise a total of 20 weeks (working days) according to the further provisions in the Guidelines for Internships. These guidelines are part of these examination regulations (Appendix 3). If the scope of the internships completed by the applicant fall short of the practical work to be performed as part of the bachelor's degree program in Mechanical Engineering at RWTH, the Examination Board will only grant admission with the expectation that the student will submit proof of having completed another internship – the extent of which is to be specified in more detail – by the time they register for their master's thesis.

(6) § 3 (12) GER applies when determining whether the admission requirements are met.

(7) General regulations for the recognition of credit points are provided in § 13 GER.

(8) For graduates of a 6-semester bachelor's course of study, the Examination Board specifies that students must have attained at least 30 credit points (CP) by the time they register for their master's thesis. If further additional requirements amounting to more than 30 CP are imposed due to gaps in the foundational academic skills and knowledge defined in paragraph 2, admission to the master's program cannot be granted.

§ 4
Standard Period of Study, Curriculum, Credit Points, and Required Coursework

(1) The standard period of study is three semesters (one and a half years) full-time, including completion of the master's thesis. Students can only begin their studies in the winter semester, and the program's curriculum is structured accordingly.

(2) The course of study consists of a mandatory and a core elective component.
For successful completion of the degree program, a total of 90 credit points must be earned.
The master's examination is comprised of the following components:

Mandatory modules	38 CP
Core elective modules	22 CP
Master's thesis	30 CP
Total	90 CP

(3) The degree program, including the master's thesis module, is comprised of 12 to 13 modules. All modules are specified in the module catalog. The weighting of the assessments to be taken in the individual modules is carried out according to § 4 (4) GER.

§ 5
Obligatory Attendance in Classes

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

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

(2) Classes with obligatory attendance in accordance with paragraph 1 shall be indicated 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
Forms of Examination

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

(2) The following other form of exam is stipulated according to § 7 (1) GER:

- Students who come to RWTH Aachen University through the exchange program with Tsinghua University are required to submit a "Mini Thesis" of 25 to 60 pages, which should take them around 270 hours to complete.

(3) The duration of an exam is as follows:

- 60 to 120 minutes for up to 5 CP
- 120 to 180 minutes for 6 to 9 CP
- 180 to 240 minutes for 10 to 15 CP
- 240 to 300 minutes for 16 CP or more.

(4) Oral exams shall last 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 4 candidates.

(5) Term papers shall range from 10 to 20 pages. Students are expected to spend approximately 150 hours on writing a term paper.

(6) The written version of an oral presentation shall range from 5 to 10 pages. Presentations shall take a minimum of 15 minutes and up to a maximum of 45 minutes.

(7) The following applies specifically to colloquia: the duration of a colloquium shall be 30 to 60 minutes.

(8) At the beginning of the course associated with an exam, the examiner will specify how long students will have for the exam.

(9) Admission to module exams may be conditional on the successful completion of module components in accordance with § 7 (15) GER. This is outlined for the relevant modules in the module catalog. At the start of the semester, or by the first session of the course, the instructor shall provide the students with precise criteria online in the CMS regarding opportunities to improve their grades by completing module components, specifically indicating the number and type of tutorials that can be taken for extra credit and the methods of correction and assessment.

(10) Exam durations deviating from the regulations in paragraphs 2 to 7 for modules from other faculties are to be indicated in the respective module description.

§ 8
Assessment and Grading

(1) General regulations for assessing exams and the formation of grades are stipulated in § 10 GER.

(2) If the master's thesis consists of several components, each component must be passed, i.e. be completed with the grade of at least "sufficient" (4.0).

(3) A module has been passed if all associated exams have been passed with a grade of at least "sufficient" (4.0), and all other credit points or module components have been achieved according to the relevant course of study-specific examination regulations.

(4) The overall grade is formed taking into account all module grades and the grade of the master's thesis according to § 10 (10) GER.

(5) In the case that all module examinations of the master's course of study have been completed within the standard period of study, one weighted module grade – except grades for master's thesis work – can be deleted according to § 10 (13) GER.

§ 9
Examination Board

The responsible Examination Board according to § 11 GER is the Examination Board for Mechanical Engineering at the Faculty of Mechanical Engineering.

§ 10
Repeating Exams or 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 an area of this master's course of study can be replaced by another upon application to the Examination Board, provided that this is permitted in the module catalog and no assessments or exams have been completed as of yet. It is not possible to substitute mandatory modules.

§ 11
Cancellation of Registration, Non-Attendance, Withdrawal, Deception, Non-Compliance

(1) General provisions on cancellation of registration, non-attendance, withdrawal, deception, or non-compliance are stipulated in § 15 GER.

(2) The following applies to canceling a registration in lab courses and seminars: canceling a registration in 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. examinations that are to be completed based on the structure of the course of study according to § 4 (2) and detailed in the module handbook according to appendix 1, as well as

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

(2) The order of courses is based on the curriculum (Appendix 1). The master's thesis can only be registered once the student has attained 45 credit points.

§ 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) This thesis can be written in German or English, in agreement with the examiner in question.

(4) The allotted time (time frame for completion) for the master's thesis is usually a minimum of 18 and a maximum of 22 weeks. In justified exceptional cases, the writing time can be extended by a maximum of up to six weeks upon application to the relevant examination board in accordance with § 17 (7) GER. The thesis should not exceed 80 pages (excluding appendices).

(5) The candidate presents the results of their master's thesis in a master's final colloquium – § 7 (12) GER in connection with § 7 (7) apply accordingly. The master's final colloquium may be held before the master's thesis is submitted.

(6) The work required for preparing and writing the master's thesis as well as for 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.

III. Final Provisions

§ 15
Viewing of Examination Records

Review of exam documents is carried out in accordance with § 22 GER.

§ 16
Entry into Force, Publication, and Transitional Provisions

(1) These regulations shall be published in the official announcements of RWTH Aachen University ("Amtliche Bekanntmachungen") and enter into force as of the 2020/2021 winter semester.

(2) These examination regulations apply to all students enrolled in the Automotive Engineering master's course of study at RWTH for the first time in or after the 2020/2021 winter semester.

(3) Students who enrolled in the Automotive Engineering master's course of study before the 2020/21 winter semester may apply to transfer to the present version of the examination regulations. Students can no longer pursue their studies on based on the currently valid version of the examination regulations from December 18, 2015, after the 2022/23 winter semester. After the 2022/2023 winter semester has concluded, students must transfer to the present version of the examination regulations.

(4) Students will receive credit for credit points they earned during studies based on the latest valid version of the examination regulations originally published December 18, 2015, according to the Equivalence List in Appendix 5 if they fulfill the requirements of the present examination regulations.

Issued based on the resolutions of the Faculty Council of the Faculty of Mechanical Engineering dated January 28, 2020.

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 of procedure in a complaint, specifying the infringed legal provision and the fact which 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 September 17, 2020

sgd. Rüdiger
Univ.-Prof. Dr. rer. nat. Dr. h. c. mult. Ulrich Rüdiger

Appendix 1: Curriculum

Master programme in Automotive Engineering of RWTH Aachen University

Compulsory Courses

Modulverantwortliche	Academic	Module	CP	L	P/L	∑ CH	summer / winter	∑ CP
Eckstein / Pischinger	Eckstein / Pischinger	Alternative and Electrified Vehicle Propulsion Systems	5	2	1	3	s	68
Eckstein	Eckstein	Automotive Engineering III	5	2	1	3	w	
Sauer	Sauer	Battery Storage Systems	5	2	1	3	w	
Pischinger	Pischinger	Internal Combustion Engines: Design and Mechanics	6	2	2	4	s	
Hüsing	Hüsing	Machine Dynamics of Rigid Systems	6	2	2	4	s	
Schröder/Sprehe	Schröder/Mekala/Sprehe	Processes and Principles for Lightweight Design	6	2	2	4	w	
Urban	Urban	Structural Design of Vehicles	5	2	1	3	s	
		Master Thesis	30				sw	

Elective Courses

Modulverantwortliche	Academic	Module	CP	L	P/L	∑ CH	summer / winter	∑ CP
Schleifenbaum	Schleifenbaum	Additive Manufacturing	6	2	2	4	w	
Itskov	Itskov	Advanced Finite Element Methods for Engineers	5	2	2	4	w	22
Poprawe	Poprawe	Applications of Laser Technology	6	2	2	4	s	
Eckstein	Eckstein	Automotive Engineering - Practical Course I&II	6	0	4	4	w&s	
Eckstein	Eckstein	Automotive Engineering IV - Automated Driving	5	2	1	3	s	
Schwalm	Schwalm	Automotive System Evaluation	5	2	1	3	s	
Eckstein	Löwer/ Böddeker	Cooperative Product Design in Automotive Engineering	6	1	3	4	s	
Abel	Abel	Control Engineering	5	2	1	3	w	
Oeser	Oeser	Environmental Sustainability in Transport Engineering	6	2	2	4	w	
Schröder	Schröder	Fatigue Design of Lightweight Structures	5	2	2	4	s	
Schmitz	Schmitz	Fundamentals of Fluid Power	6	2	2	4	w	
Brecher/Klocke	Brecher/Klocke	Gear and Transmission Technology	6	2	2	4	w	
N.N.	N.N.	Industrial Engineering	5	2	2	4	w	
Pischinger	Pischinger	Internal Combustion Engines: Thermodynamics and Emissions	6	2	2	4	w	
Natour	Natour	Measurement and Testing Methods in Joining Technology	6	2	2	4	ws	
Markert	Markert/Jenkouk	Mechanics of Forming Processes	5	2	2	4	w	
Brecher	Brecher	Mini Thesis **	9	0	0	270	sw	
Vallée	Vallée	Mobility Research and Transportation Modeling	6	2	2	4	s	
Markert	Markert	Molecular Mechanics and Multiscale Modelling of Materials	5	2	2	4	w	
Markert	Markert	Porous Media Mechanics	6	2	2	4	s	
Schmitt	Schmitt	Quality Management	6	2	2	4	w	
Eckstein	Eckstein	Self-Driving Lab - Programming Automated Vehicle	2	1	0	1	s	
Jacobs	Jacobs	Tribology	6	2	2	4	w	
Biermann	Biermann	Vehicle Acoustics	5	2	2	4	s	

* The total amount of weekly contact hours (SWS) depends on the modules selected.
** Only for Tsinghua University exchange Students

Appendix 2: Guidelines for Internships

Guidelines for Internships for Students of the Bachelor's Degree Program in Mechanical Engineering at RWTH Aachen University

(As Decided by the Faculty Council in May 2013)

1. Purpose of Internships

For students to sufficiently understand the content taught in technical lectures and through exercises and to prepare them for their jobs after graduation, it is essential that they receive visual instruction on the practical principles of the chosen profession.

The practical instruction of students enrolled at universities of technology is an essential prerequisite for successful studies and it is also an important part of the curriculum.

Internships allow students to learn how materials are produced, shaped, and processed and discover the products' particular structure and their mode of action in a real-life setting. They should also become familiar with inspecting finished components, assembling machines and equipment, and installing them on site. They will also be given an overview of the areas that precede production, such as design and preparatory work.

Interns should also take a special interest in the social structures in the firm.

2. Duration and Timing

Before the Start of Studies

Students must prove that they have completed a 6-week internship when they enroll (for exceptions, see item 12). It is recommended that these 6 weeks be completed in the area of the basic internship. The training period in a firm should be at least three weeks. Students must only submit the internship certificate (no reports) for enrollment. Enrollment does not automatically result in the accreditation of the pre-study internship. The university will check that the student has completed the internship according to the guidelines and then recognize it for credit if everything is in order only after the student has already taken up studies. Students must submit all internship documents (internship certificate and reports) to the Internship Office by the end of the 1st semester without being prompted by the staff at the Internship Office.

During Studies

Practical training in the program lasts 14 weeks for mechanical engineering students. Students should plan to complete these weeks during the internship semester (7th semester), which is specifically provided for this purpose in the curriculum. The training period at a firm should be at least 3 weeks. The internship must be fully completed and recognized by the time the student registers for their bachelor's thesis.

3. Accreditation of the Internship, Credit Points

To have the internship recognized for credit, students must submit the work report, the internship certificate, and give a presentation about their practical training. Details are regulated in paragraphs 9, 10, and 11. 14 credit points are awarded for an accredited internship.

4. Training Curriculum

The following training curriculum lists the required activities for the basic internship and the electives for the specialized internship. It should be noted that any additional weeks, exceeding those listed under "maximum number of weeks," cannot be considered.

Type of Activity		Number of Weeks	
Basic Internship From the basic internship area, the activities GP1 to GP4 must all be completed in the minimum number of weeks allowed.		At minimum	At maximum
GP1	Machining processes	2	4
GP2	Forming manufacturing processes	1	2
GP3	Thermal joining and separation processes	1	2
GP4	Forming processes	1	2
Specialized Internship Part A From Part A of the specialized internship, internships must be completed in at least two of the six listed areas of activity (FP1 - FP6).			
FP1	Heat treatment	1	3
FP2	Tool and fixture construction	1	3
FP3	Maintenance, service, repair	1	3
FP4	Measuring, testing, quality control	1	3
FP5	Surface technology	1	3
FP6	Assembly	1	3
Specialized Internship Part B Students are encouraged to complete a specialized internship from Part B, but it is not required.			
FP7	Development, design, preparatory work	0	8
FP8	Course of study/specialization-specific project internship after consultation with the Internship Office	0	8
	Required number of weeks		**20**

Details on the Training Curriculum

The individual sections can be completed in any order. However, it is recommended that activities from the specialized internship not be started until the basic internship has been completed.

GP1: Machining processes on metallic materials:

z. E.g. filing, chiseling, sawing, drilling, countersinking, reaming, threading by hand, turning, planing, milling, grinding, lapping, broaching, honing.

GP2: Forming manufacturing processes on metallic materials:

e.g. open-die and closed-die forging, impact extrusion, extrusion, stretching, swaging, upsetting, coining, drawing, rolling, deep drawing, stretch drawing, spinning, stamping, fine blanking, bending, straightening, riveting.

GP3: Thermal joining and separation processes:

z. E.g. oxyacetylene welding, arc welding, resistance welding, flame cutting, special welding and cutting processes, soldering. Basic courses for gas fusion and electric welding offered by the "Deutscher Verband für Schweißtechnik e.V." are recognized.

GP4: Primary forming processes of iron, non-ferrous metals, plastics:

Structure and layout of a model, composition of box parts and model cores, mold making, hand molding with models and templates, getting to know wet and dry casting, working in the core shop, in the machine molding shop and casting (sand casting, investment casting, permanent mold casting, die casting, centrifugal casting, continuous casting). Please note: This internship section must include an opportunity to observe the casting process. Sintering: Manufacture of pressed parts based on powder metallurgy. Plastic syringes.

FP1: Heat treatment:

z. E.g. normalizing, soft annealing, diffusion annealing, hardening and tempering of workpieces and tools, case hardening and nitriding.

FP2: Tool and fixture construction:

z. E.g. manufacture and repair of tools, jigs, fixtures, measuring tools, templates.

FP3: Maintenance, servicing, and repair:

e.g. maintenance and repair of operating equipment and facilities.

FP4: Measuring, testing, quality control:

e.g. mechanical, electrical, pneumatic, optical measuring methods, gauges, surface metrology, special measuring methods in mass production; getting to know the production-related tolerance variables and the relationship between accuracy and costs.

FP5: Surface Technology:

z. E.g. surface coating (painting, electroplating, enameling, fluidized bed sintering, etc.) including preparation.

FP6: Assembly:

e.g. pre-assembly and final assembly in the individual and series production of machines, vehicles, assembly apparatuses, and lines.

FP7: Developing or designing machines, equipment, and processes; preparatory work.

FP8: Course of study/specialization-specific project internship in consultation with the Internship Office:

Through practical engineering-related work in companies, students should be introduced to the professional activities of an engineering graduate in their field of study/specialization. Students shall apply the knowledge and skills they have acquired during their studies up to this point.

5. Applying for an Internship

Students shall search for a suitable internship position on their own. Before starting their training, the future intern should use these guidelines or, in special cases, contact the Internship Office of the Faculty of Mechanical Engineering at RWTH Aachen University directly to familiarize themselves in detail with the regulations for completing the internship, reporting on internship activities, etc.

The employment office responsible for the training location and the relevant chamber of industry and commerce shall provide information about which firms are suitable and recognized for training interns.

6. Training Companies

To complete their basic internship or their specialized internship part A in Germany, students may only apply to firms that have been authorized to carry out internships by the Chamber of Industry and Commerce – since it is only at these firms that students will be given complete insight into the work processes from an industrial perspective (as being greatly influenced by deadlines and costs) and get to experience the social aspects of the work in addition to acquiring the required knowledge.

Internships at trade and repair businesses – which typically do not manufacture goods but are primarily involved in service and maintenance –, at university institutes, or a student's or parental firm cannot be recognized for credit. Internships at vocational training centers and research institutes can only be recognized in exceptional cases after consulting with the Internship Office and only for the basic internship with up to a maximum of 6 weeks.

The total of all non-industrial activities may not exceed six weeks. The Internship Office must approve suitable internships before the students begin their work placement. The training curriculum must be adhered to.

7. Interns' Behavior at the Training Company

Interns do not enjoy any special status during their internship. They can win the respect of their superiors and other employees at the company by conscientiously observing the company rules, keeping to working hours and company discipline in an exemplary manner, and distinguishing themselves through diligence, good performance, and a willingness to help. In addition to organizational interrelationships, machine technology, and the relationship between machine and manual work, interns should also understand the human side of operations and its influence on the manufacturing process.

In this context, they should also learn about the relationship between lower and middle managers and employees at their workplaces and empathize with them in case of potential social problems.

8. Supervision of Interns

When students complete their internships at suitable manufacturing businesses, they are usually supervised by a designated training manager, who ensures they receive meaningful training in line with the company's training opportunities and in compliance with the internship guidelines. They will teach interns about the various professional topics in meetings and through discussions.

The Internship Office will also assign a professor to the interns who will supervise them and be available to provide them with professional guidance over the course of their internship.

University interns are not required to attend vocational school. Voluntary participation in manufacturing classes must not affect the already short internship placement at machine shops.

9. Internship Reporting

During their internship, students must write a report about their activities and any observations they make as they fulfill their tasks.

This internship report shall contain descriptions of the various training sections in a coherent text (not daily reports) and give an account of the experiences the student was able to gain during their work placement (machining examples, problems in the manufacture of mechanical engineering products, defects in machines, effects of machines on people and the environment, problems with business organization). A table of contents and a brief description of the firm offering the internship position (industry, size, product range) should also be included. For preparing their internship reports, students should use either report books or DIN A4 sheets that are bound together in a folder.

In their internship reports, students are expected to prepare approx. 2 DIN A4 pages (of sketches and text) per week spent at the internship firm.

Internship reports shall be prepared on a computer. Worksheets and copies (e.g., of guidelines, literature, etc.) cannot be substituted for text the students must produce. All reports must be stamped and signed by the intern's trainer.

10. Internship Certificate

At the end of the work placement, the intern receives a certificate from the training company stating the duration of the training in the individual departments and the number of days absent due to illness and vacation. The internship certificate must be issued by the company where the internship was carried out. Certificates from recruitment agencies cannot be accepted.

11. Recognition of the Internship and Issuance of the Overall Certificate of Attendance

The Internship Office of the Faculty of Mechanical Engineering at RWTH is responsible for recognizing the internship and issuing the overall confirmation of attendance. To have their internship recognized for credit, students must have prepared the internship report, received evidence of having completed the internship and have given a presentation about their practical training.

Internship Report, Internship Certificate

In order for their internship to be recognized, students must submit the original of their internship report duly drawn up in accordance with paragraph 9 and the internship certificate issued in accordance with paragraph 10. In any case, the nature and duration of the activity in the individual training sections must be clearly evident from the documents. Affidavits are not accepted as a substitute for internship certificates.

The internship documents must be submitted to the Internship Office for credit no later than 6 months after the internship has been completed – for first-year students, no later than the end of the 1st semester. Late submission may result in non-recognition of the internship section due to lack of verifiability.

The Internship Office decides to what extent the practical activity meets the guidelines and can therefore be recognized as an internship. It may impose additional weeks of training if internship certificates and reports do not indicate sufficient completion of individual sections of the internship. Training for which a sloppy or incomprehensible report is submitted may not be recognized, or may be recognized only for part of its duration. The Internship Office certifies the length of time officially recognized as an internship on the internship certificate issued by the training company, which students must submit along with their report.

The student will not be notified by the Internship Office of the outcome of the review. It is the students' responsibility to make sure their internship has been recognized. Students are urged to find out about the internship's recognition status from the Internship Office early enough so they can supplement or repeat internship sections if necessary.

Presentation:

The students must report on their completed internship by giving a presentation at the institute of the supervising professor at the Faculty of Mechanical Engineering. The nature and duration of this presentation shall be determined in consultation with the professor. After students have held their presentation and a subsequent discussion has taken place, the professor will issue a certificate, which the students must submit to the Internship Office along with their internship certificates to have their practical training recognized.

Overall Certificate of Attendance

An internship will only be fully recognized if it has been completed in full to the required extent. Students must submit the original copies of all internship certificates certified by the Internship Office. The Internship Office will then prepare the internship form. This form must be signed by the supervising professor and submitted once more to the Internship Office for a final signature.

Appeals against decisions of the Internship Office and the supervising professor may be filed with the Examination Board.

12. Bundeswehr, Civilian Service

Applicants who can prove that they are unable to complete the prescribed six-week internship period before starting their studies due to the date of completion of their military or civilian service may also be admitted to the program without a pre-study internship.

Training periods in technical units of the German Armed Forces (Bundeswehr) can be credited toward the internship if activities serving one of the Bundeswehr's material maintenance and preservation levels (MES) were carried out in the assigned unit. A maximum of two weeks per material maintenance and preservation level (MES) can be recognized as an internship. To have such work experience recognized, students must submit the relevant certificates to the Internship Office. Students do not have to submit reports on this type of work experience. It is up to prospective students wishing to later enroll in a course of study with the above pre-study internship requirements to apply for placement in a suitable technical unit prior to beginning their military service. Information can be obtained from the military service advisory service (Wehrdienstberatung) at the responsible Bundeswehr career center. The same applies to civilian service.

13. Recognition of Previous Practical Experience

Prior work experience – e.g. completed vocational training, periods of professional activity, etc. – can be recognized to the extent that the training sections prescribed in paragraph 4 were part of the vocational training.

14. Internships Abroad

Students are encouraged to also complete internships abroad. The above guidelines shall govern the accreditation of such internships. To avoid problems with accreditation, students should coordinate the internship abroad with the Internship Office in advance.

Students can obtain information about internships abroad and opportunities for financial support from the German Academic Exchange Service (DAAD) from the International Office.

These guidelines apply without exception to all applicants from abroad who wish to come to Germany to study at RWTH Aachen University.

The internship report and the internship certificate must be in German or English. Internship certificates are accepted as official certified translations into German or English, provided that the original in the corresponding national language is also submitted.

15. Exchange Programs

The scope and content of the internship required as part of an exchange program is governed by the relevant contractual agreements of the partner universities.

16. Internship Contract

The internship placement becomes legally binding through the internship contract concluded between the company and the intern. The contract should specify all the rights and obligations of the intern and the training company.

17. Vacation, Medical Leave, Absences

Due to the short training period, interns cannot be given leave. Working time lost due to illness must be made up. In case of absences, interns should ask their training company to extend the contract to allow them to complete the training period they have begun as required.

18. Compulsory Insurance

Students can obtain information regarding compulsory insurance by contacting their respective health insurance providers. Insurance coverage for internships abroad is provided by an insurance policy taken out by the intern or the training company.

19. Address of the Internship Office

RWTH Aachen University
Internship Office of the Faculty of Mechanical Engineering
Kackertstr. 9
52056 Aachen

Email: praktikantenamt@fb4.rwth-aachen.de
Website: www.maschinenbau.rwth-aachen.de/studium/praktikantenamt
Telephone: 0241 80 95306
Fax: 0241 80 92701

Opening hours: see website

Appendix 3: Description of the Required Knowledge and Skills

Mechanics I/II/III (18 CP):

Academic Knowledge:

Students must demonstrate mastery particularly in the following areas:

- the basic theories of forces in statically determined systems
- the method of representation in internal forces diagrams for statically determined linear structures
- the special features of friction systems and equilibrium positions as well as corresponding determination methods
- the advanced concepts of infinitesimal movements and the principle of virtual work and its possible applications
- the mechanics of deformable bodies with stress states based on general mechanical principles
- the kinematics of the rigid body
- structures, structural elements, and load limits of bodies
- properties of strain and experimental setups of tensile tests
- procedures for motion tasks, equations of motion, changes in shape
- principles and theories of gyroscopic motion, oscillations and degrees of freedom
- mathematical representation and calculation methods.

Students must be able to explain the basic theories and understand the concept of statically determined systems with its advantages and disadvantages and manage to critically examine results.
They can explain the principles and methods and apply them to various issues.

Skills and Competencies:
Students must be able to illustrate acting forces for central force groups in geometric terms, including the acting forces' position in space and equilibrium conditions. For example, they can investigate the stability of potential systems.
Using such representations and thanks to having developed critical awareness, students should be able to evaluate the effect of forces and define inconsistencies, especially when it comes to the stability of force development and transmission.
They can describe the problems defined in this way using mathematical analytical methods in systems of low or medium complexity and find possible solutions.
Students are able to mathematically illustrate mechanical states of deformable and rigid bodies after hearing a verbal description and calculate the following:

- load limits and deformations, especially for bars, beams, tubes, and trusses
- based on energetic methods, they can calculate forces and moments in statically indeterminate systems,
- calculate the movement of mass points,
- vibrations of single and multiturn undamped harmonic transducers,
- damped and fanned vibrations in single- and multi-rotor systems, and
- externally excited oscillations.

Thus, students must particularly be able to assess stability states of simple structural elements and determine the load limits by selecting the appropriate methods.

Machine Design I/II/III and CAD (13 CP)

Academic Knowledge:
Students must demonstrate mastery in the following areas:

- the main conventional machine elements for implementing connections for power and force transmission,
- the basic rules for designing and constructively integrating these machine elements in assemblies and the applicable technical standards,
- various standardized methods of visually representing technical structures, in particular also the machine elements mentioned,
- 3D CAD systems and their functionality,
- the basic functionality of a PDMS (Product Data Management System) and
- fundamentals of conventional machining processes and welding necessary for the preparation of drawings and dimensioning appropriate for production.
- fundamentals of strength calculation of metallic components with a focus on fatigue strength and operational strength verifications using the example of the machine elements shafts and axles
- function and designs of rolling bearings, their mathematical design and the design of bearing arrangements with rolling bearings
- oil viscosity
- functions of hydrodynamic sliding layers and methods for their operationally safe design
- different designs of springs and the corresponding material stresses; interpretation of typical spring characteristics; calculation, combination, and design methods of springs
- assessment, selection, and comparison of common joining methods
    - basic terms, design, and calculation of material-bonding fasteners such as soldered, bonded, and welded joints
    - the design of form-fit and force-fit fasteners such as riveted or bolted joints in accordance with relevant guidelines; operating behavior of bolted joints based on the stress diagram; basic principles and design rules
- different designs of positive and non-positive traction gears; calculation methods for determining the geometric relationships, power transmission, efficiency and strength of traction gears
- basic design forms of shaft-hub connections in material-, form- and force-locking design, as well as their calculation and design methods
- types of function and areas of application of different types of switching and non-switching couplings as well as methods for their design
- basics of the gear geometry of straight and helical spur gears
- load capacity verification of involute gears with regard to tooth flank, tooth root, and scuffing load capacity
- basics of gearboxes and gearbox variants with in-depth study of the calculation methods of planetary gearboxes.

Students must thus be able to understand a technical issue represented in a drawing by means of a standardized representation method and explain the relationships and special features shown.

They must also be able to create assembly drawings representing mechanical engineering designs and, in conforming to standards, produce dimensioned production drawings for parts with applicable specifications such as types of welds. Students must be able to specify all relevant dimensional, form, and position tolerances, surfaces and edge conditions in doing so.
Accordingly, students must have obtained a comprehensive theory-based understanding and fundamental knowledge in the field of machine design. They can now apply their basic knowledge of higher mathematics, engineering mechanics, and materials science as well as technical drawing to individual machine elements and their design-specific requirements. Students have learned to design machine elements taking into account the application-specific conditions of use with the aid of standards and guidelines.

Skills and Competencies:
Students must be able to use the available 3D modeler to produce models, particularly of turned, milled, and cast parts, using the modeling strategies and techniques they have learned. They can also define product structures and assemble the CAD models of the parts into CAD assemblies.
They can recognize and explain connections between the fundamentals of manufacturing processes, the representation rules of standardization, and CAD modeling technology. This also includes knowing the limits of their respective applicability.
Students can use drawings to evaluate the functionality of assemblies, contrast solution options to assess suitability, and thus make an informed decision.
Their program's lectures and accompanying exercises must have taught students to recognize basic technical relationships of machine design and analyze the function and stress of machine elements in technical systems on their own. Students have developed the ability to design machines, select suitable machine elements, and design them reliably. In this context, students must have become familiar with the relevant technical standards for the design of machine elements. Students can interpret the results obtained in component design and, if necessary, derive useful optimization options with regard to machine design.
The skills students have acquired should allow them to put the techniques and methods into practice and work on engineering problems. They must thus have acquired the competencies to carry out mechanical engineering designs independently or to work in a team with other specialists. In addition, students must be able to clearly present the results of their work verbally and in writing, and to argue in a scientifically sound manner.

Other:
In the computer-aided processing of problems, students have been trained in the use of industry-standard software for the standard-compliant design of machine elements.
By completing this module and working on the assignments independently, students have also improved their methodological skills as well as their project and time management. They are able to independently plan and schedule their learning process and fit it into their studies in a timely manner and in the correct form.

Thermodynamics I/II (7 CP):

Academic Knowledge:
Students must have acquired fundamental engineering and scientific knowledge of mechanical engineering and, in particular, the subject area/professional field of energy and process engineering. Thus, they are familiar with the basics of technical thermodynamics and can compare and categorize the most important thermodynamic processes in terms of efficiency and energy quality.
They are familiar in particular with:

- the basic laws of energy and material transformations,
- application-relevant technical processes in energy and process engineering,
- substance models for pure substances and mixtures with their thermal state variables,
- balances (quantities of matter / mass, energy, entropy).

Skills and Competencies:
Students must be able to describe the most important thermodynamic and chemical processes (e.g. in heat pumps, combined heat and power plants, combustion processes, equilibrium reactions) and to explain and evaluate the corresponding processes and influencing variables. To this end, they can create various balances, as well as identify and apply suitable substance models.
They have learned to analyze tasks and apply various basic approaches, and to examine them for their efficiency. This enables them to develop their own professional solutions using the knowledge described in the section on academic knowledge above, while adhering to subject-specific design rules.

Heat and Mass Transfer I (6 CP):

Academic Knowledge:
Students must particularly master the following areas:

- the heat and mass transfer mechanisms radiation, heat conduction, diffusion, and convection
- mathematical models to describe these mechanisms and the assumptions to be made
- dimensionless key figures for the representation of relevant influencing variables:

This should enable them to identify and describe relevant mechanisms for heat and mass transfer in technical systems. They must also be able to explain the analogy between heat and mass transfer.

Skills and Competencies:
Students must be proficient in the mathematical description of problems by reducing them to essential influencing variables, which are formulated with dimensionless key figures.

After developing such equations, the students must also be able to solve them for the specified mechanisms according to known mathematical formulas and use the results to interpret the mechanisms used. In doing so they also take into account the assumptions underlying the calculation and assess their feasibility and inherent risks.

Students must be able to abstract more complex problems from applications and translate them into a mathematical description.

This allows them to solve thus formulated problems mathematically, estimate the validity limits of the solution, and also check the correctness of the simplifications made. In particular, students must have learned how to create balance systems.

Other Competencies (Optional):
In addition, the following can be considered strategic competencies for the students to have acquired:

- analyzing a task
- investigating approaches for solving it
- comparing and contrasting partial solutions
- selecting an overall approach for solving the task through critical comparison and justification
- designing and developing the solution
- having the skills to combine theory and practice in order to analyze and solve engineering and informatics problems in a methodical and basic way, and
- understanding applicable techniques and methods and their limitations.

Materials Science I/II (8 CP):

Academic Knowledge:
In their courses on **Materials Science I**, students must have covered the most important fundamentals of the materials science of metallic materials.
A first section must have dealt with the most common standardized mechanical test methods and explained the mechanical behavior of metallic materials to students. A second section must have dealt with metallurgical fundamentals, starting with the structure of crystalline materials, lattice defects and diffusion, followed by various aspects of plastic deformation, recovery and recrystallization. This section must have concluded with state diagrams and phase transformations. A third section must have dealt with mechanical engineering materials, their heat treatment and use.
In relation to metals, students must be familiar with the following in particular:

- the mechanical behavior of metallic materials
- the most important test methods of mechanical materials testing
- the structure of metallic crystalline materials
- grid construction errors
- diffusion
- the concepts of recovery and recrystallization
- state diagrams
- phase diagrams and transformations
- heat treatment and its application
- standardized designation of steels, cast irons and aluminum materials.

Accordingly, the students know the relevant criteria for materials or their processing, such as stress capacity, and the associated condition measurement methods.
In **Materials Science II**, students must have become familiar with materials science for **plastics** and **ceramics** and know how to differentiate them from metallic materials.

With regard to ceramics, students must be familiar in particular with:

- the ceramic sectors silicate ceramics, refractory, and advanced ceramics with detailed knowledge about the materials, processes, costs, and quality requirements
- atomic bonding ratios and crystal structures
- typical physico-chemical and mechanical properties
- the process chain for manufacturing the components
- preparation and shaping methods and their typical structural defects
- reinforcement methods such as dispersion, short and long fiber, and conversion reinforcement
-

With regard to plastics, students must be familiar in particular with:

- the necessary auxiliaries and fillers to achieve desired fabric properties
- influencing factors in the manufacturing and processing process
- plastics-specific analysis, processing, and manufacturing methods
- basic design guidelines for the design.

The students are thus able to distinguish between the typical material groups for plastics technology, thermoplastics, elastomers, and thermosets, and know the typical processing options, e.g. as composites.
In the area of metals, students are able to distinguish properties caused by modifications in the composition of materials or by the forming process or heat treatment. They are also aware of the influence of deformation and heat treatment on the mechanical properties of metals. They know at which points in the manufacturing process alterations can be made in order to achieve certain component properties such as strength, ductility, creep resistance, or hardness.
In the field of plastics, they can distinguish the properties caused by modifications in the composition of the materials or by the molding process. Students can understand the computer-aided designs.
They can also name the influencing factors in the molding process. They know at which points in the manufacturing process alterations can be made in order to achieve certain component properties such as stability or heat resistance.
Thus, students understand the basic structure of metallic, plastic-based or ceramic materials as well as the main resulting processing forms.
The students are able to place different items made of plastics or ceramics – or their properties – in relation to one another or also to the material metal, to differentiate between them in terms of component design and possible applications, and to explain the advantages and disadvantages in the production process.
In the field of metals, they can explain in particular the different microstructural characteristics of steels and the influence of heat treatment on microstructural and material properties.
In the field of ceramics, they are able to explain the influencing factors in the individual steps from the raw material and powder preparation to the shaping and sintering process, concluding with the hard machining. They can describe the chemical and mechanical properties of ceramics and explain the influences of these properties on the manufacturing process and the product. They understand that the sintering process is temperature-activated via atomic mass transfer mechanisms and can draw semi-quantitative conclusions about the preceding and still following sintering process from microstructure templates.

<u>Skills and Competencies:</u>
Students must be able to research, compare, and interpret the necessary mechanical or thermal material properties for specific material applications.
By comparing the characteristic properties of the different materials, students can make statements about which materials or combinations of materials are suitable for the applications and the associated requirements.
In the field of ceramics, they can derive the mechanical properties of fracture strength, fracture resistance, and defect size via the Griffith equation from both the energy concept and the stress concept.
From measured values of strength and using representation methods such as Wöhler diagrams, creep diagrams or fracture statistics and real examinations of fracture surfaces, students can make statements about reliability and service life. In the field of metals, they can also analyze notch stresses and crack patterns in components.
The students have also acquired the ability to recognize possible sources of error in the design and manufacturing process of components on the basis of these derivations, representations, and investigations and to initiate theory-based measures to eliminate them.

Automatic Control (6 CP):

<u>Academic Knowledge:</u>
Students must demonstrate mastery in

- the fundamental properties of dynamic systems,
- model descriptions of dynamic systems, and
- methods for describing cause-effect interactions
-

especially mathematical methods for the analysis of

- linear differential equations
- the stability of linear systems
- the closed control loop
- the controller design process
- meshed control loops
- the effects of digital computers
- discrete event systems.

As a result, students are able to classify dynamic systems and distinguish between them depending on their dynamics.
They can apply their knowledge to equipment technology (hardware and software) in the area of automation tasks in industrial production processes from the field of energy and process engineering as well as from manufacturing and assembly technology.

<u>Skills and Competencies:</u>
Students must have learned to translate dynamical systems into mathematical models by describing them in abstract terms. Furthermore, they can select the form of description for linear systems in a well-founded manner, analyze this form in terms of control engineering, identify suitable controller structures and independently design suitable controllers. They can perform the necessary calculations both numerically and graphically. They are also able to evaluate and quantify the performance of the designed controller.

Fluid Mechanics I (6 CP):

Academic Knowledge:
In the field of density-resistant fluids, the students must master in particular

- the terminology of fluid mechanics
- the scientifically founded conditions of the validity of the basic forms of the conservation equations
- the forms of the conservation equations in Cartesian, polar, and cylindrical coordinates
- the method of translating these approaches to generic problems within the framework of one-dimensional theory
- the interdependencies between generic and applied issues.

Skills and Competencies:
Students must know what the requirements for equations are and how to apply them. Results thus obtained allow them to later work on multidimensional problems – for instance, in more advanced courses.

Other Competencies (Optional):
Thanks to opportunities for working on exercises as a team with others in their course, sometimes over several weeks, students may furthermore be credited for having developed personal and social skills through independent and persistent effort. They are thus able to plan and schedule their own approach to a problem, distribute tasks and take responsibility for their results, i.e. formulate them and apply them to the overall process in due time and form. They are able to choose appropriate presentation and formatting methods on their own authority. They have developed teamwork skills through working on various exercises and problems.

Mathematics I/II/III (17 CP):

Academic Knowledge:
Students must demonstrate mastery particularly in the following areas:

- number systems (integers, rational, real and complex numbers), basic concepts of logic, sets
- elementary functions: polynomials, rational functions, trigonometric functions, exponential function, natural logarithm
- limit value concept of sequences, series and functions, continuity
- basic concepts of differential calculus: the definition of the derivative, calculation rules, determination of extreme values, Taylor series
- basic concepts of integral calculus: the definition of the integral, main theorem of the differential and integral calculus, integration methods
- basic concepts of linear algebra: vector spaces, linear systems of equations, matrices, Gauss algorithm, determinants, eigenvalues
- basic concepts of multidimensional analysis: continuity, partial differentiation, theorem on implicit functions, multidimensional extremal problems, compensation calculus
- ordinary differential equations existence and uniqueness theorems, solution methods such as separation of variables, linear differential equation, systems of differential equations
- multidimensional integration: area and volume integrals, curve integrals, surface integrals
- vector analysis: divergence and rotation, integral theorems

- basic concepts of Fourier analysis.

Students must understand the basic mathematical concepts and techniques of one-dimensional calculus and are able to apply them to simple mathematical engineering problems, such as optimization problems.
Students must have developed a deeper understanding of basic mathematical concepts and techniques in linear algebra as well as multidimensional analysis and differential equations. This allows them to understand mathematical descriptions of technical processes and engineering calculations.

Skills and Competencies:
Students must be able to confidently deal with the terms of one-dimensional analysis, such as functions, derivatives, and integrals, as they occur, for example, in the description of technical and scientific processes. Students are able to classify mathematical problems in calculus and master approaches and computational techniques to solve these problems. This includes calculating limits, derivatives and integrals, determining the Taylor approximation to a function, and calculating maxima and minima of a one-dimensional function.
Students are able to deal with the concepts of linear algebra and advanced calculus, such as systems of linear equations, eigenvalues, functions of several variables, and differential equations as they arise in the description of engineering and scientific processes. Students master the approaches to important mathematical problems often encountered in engineering problems, such as calculating the solution to a system of linear equations, calculating eigenvalues or the determinant of a matrix, determining maxima/minima of multidimensional functions under constraints, determining solutions to systems of linear differential equations, and determining surface integrals using Gauss' theorem.

Appendix 4: Equivalence List

Automotive Engineering	CP	Automotive Engineering PO 2020	CP
keine Äquivalenz		Additive Manufacturing	6
Advanced Finite Element Methods for Engineers	5	Advanced Finite Element Methods for Engineers	5
Alternative and Electrified Vehicle Propulsion Systems	5	Alternative and Electrified Vehicle Propulsion Systems	5
Applications of Laser Technology	6	Applications of Laser Technology	6
Automotive Engineering - Practical Course I&II	6	Automotive Engineering - Practical Course I&II	6
Automotive Engineering III	5	Automotive Engineering III	5
Automotive Engineering IV - Automated Driving	5	Automotive Engineering IV - Automated Driving	5
Automotive System Evaluation	5	Automotive System Evaluation	5
keine Äquivalenz		Battery Storage Systems	5
Control Engineering	5	Control Engineering	5
keine Äquivalenz		Cooperative Product Design in Automotive Engineering	6
Electric Drives and Storage Systems	6	keine Äquivalenz	
Environmental Sustainability in Transport Engineering	6	Environmental Sustainability in Transport Engineering	6
Fatigue Design of Lightweight Structures	5	Fatigue Design of Lightweight Structures	5
Fundamentals of Fluid Power (Hydraulics and Pneumonics)	6	Fundamentals of Fluid Power	6
Gear and Transmission Technology	6	Gear and Transmission Technology	6
Industrial Engineering	5	Industrial Engineering	5
Internal Combustion Engines I	6	Internal Combustion Engines I	6
Internal Combustion Engines II	6	Internal Combustion Engines II	6
Machine Dynamics of Rigid Systems	6	Machine Dynamics of Rigid Systems	6
Measurement and Testing Methods in Joining Technology	6	Measurement and Testing Methods in Joining Technology	6
Mechanics of Forming Processes	5	Mechanics of Forming Processes	5
Mini Thesis **	9	Mini Thesis **	9
Mobility Research and Transportation Modeling	6	Mobility Research and Transportation Modeling	6
Molecular Mechanics and Multiscale Modelling of Materials	5	Molecular Mechanics and Multiscale Modelling of Materials	5
Porous Media Mechanics	6	Porous Media Mechanics	6
Processes and Principles for Lightweight Design	6	Processes and Principles for Lightweight Design	6
Quality Management	6	Quality Management	6
Self-Driving Lab - Programming Automated Vehicle	2	Self-Driving Lab - Programming Automated Vehicle	2
Structural Design of Vehicles	5	Structural Design of Vehicles	5
Tribology	6	Tribology	6
Vehicle Acoustics	5	Vehicle Acoustics	5