**Fakultät für Fahrzeugsysteme und Produktion**

Modulhandbuch

M.Sc. Automotive Engineering

Stand: April 2019

Technology
Arts Sciences
TH Köln

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Studiengangleitung

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# Inhalt

# 1 Study Objectives

The master programme Automotive Engineering prepares its graduates for management positions in the areas of research and development within the automotive industry. The students deepen their knowledge in fundamentals of automotive engineering and in application of their skills on a high scientific level. In addition, they will attain background knowledge and interdisciplinary expertise to analyze, steer and improve complex engineering processes of the automotive industry. The graduates will acquire the competence, which qualifies them to accompany the complete value chain from research, conception through development and manufacture. The students will be enabled to both lead project teams and be an effective team member themselves. They will have learnt to have an effective and goal-oriented approach to problems and to work independently even on new subject matters with demanding challenges in the areas of vehicle development. In addition, the master degree lays the foundation for further scientific qualification in the form of doctoral theses. It also qualifies the graduates for employment in the German public sector on the level of higher civil service positions (Höherer Dienst).

# 2 Curriculum

| Semester | SoSe | WiSe | SoSe/ WiSe |
|---|---|---|---|
| Credit Points | **30** | **30** | **30** |

| **Advanced Automotive Engineering** | **24** | **4** | |
|---|---|---|---|
| Adv. Body Engineering and Lightweight Design | 6 | | |
| Vehicle Concepts and Integration | 6 | | |
| Vehicle Dynamics and Automotive Chassis | 6 | | |
| Vehicle Electronics and Communication | 6 | | |
| **Electives (1 to be selected)** | | 4 | |
| Adv. Combustion Engines | x | | |
| FEA in Body Engineering | | x | |
| NVH Systems Engineering | x | | |
| Adv. Vehicle Safety | | x | |

| **Advanced Scientific Methods** | **6** | **14** | |
|---|---|---|---|
| Numerical Methods | 6 | | |
| Adv. Materials - Selection and Life Cycle Assessment | | 6 | |
| **Electives (2 to be selected)** | | 8 | |
| Adv. Thermodynamics | | x | |
| Control System Design | x | | |
| Modelling of Multi-Body Systems | | x | |
| Optimal Control and Estimation | | x | |
| Statistical Optimization | | x | |
| Structural Durability | | x | |
| Vehicle Dynamics Simulation | | x | |

| **General and Engineering Courses (2 to be selected)** | | **8** | |
|---|---|---|---|
| Automotive Manufacturing Processes | | x | |
| Corporate Management | | x | |
| Digital Factory | | x | |
| Legal Requirements and Homologation | | x | |
| Sustainability | | x | |
| Engineering Ethics | | x | |
| Automotive Supply Chain Management | x | | |

<table>
<tr><th colspan="3">Scientific and Interdisciplinary Seminars (1 to be selected)</th><th></th><th>4</th><th></th></tr>
<tr><td>Leadership Application</td><td rowspan="7">Scientific Seminar</td><td rowspan="7">Adv. Technical English-Consulting</td><td>x</td><td></td><td></td></tr>
<tr><td>Component Design, Materials and Manufacture</td><td></td><td>x</td><td></td></tr>
<tr><td>Virtual Reality</td><td>x</td><td></td><td></td></tr>
<tr><td>Cost-Efficient Product Design</td><td></td><td>x</td><td></td></tr>
<tr><td>Driver Assistance Systems</td><td></td><td>x</td><td></td></tr>
<tr><td>Mobility Concepts</td><td></td><td>x</td><td></td></tr>
<tr><td>Technology of Material Flow and Robotics</td><td></td><td>x</td><td></td></tr>
</table>

| Master Thesis | | | **30** |
|---|---|---|---|
| Thesis | | | 28 |
| Colloquium | | | 2 |

Ein „x“ kennzeichnet das Semester, in dem das Modul angeboten wird.

# 3 Lernergebnisse der Module / Modulziele

Den Lernergebnissen sowie Lernzielen (learning outcome) ist in den Modulbeschreibungen des Studiengangs ein Klassifikationsschema zugeordnet. Dieses orientiert sich im Kern an der Taxonomie von Lernzielen im kognitiven Bereich nach BLOOM[1]. Es stehen Lernziele wie Denken, Wissen und Problemlösen im Vordergrund.

Die Lernziele werden nach BLOOM[1] in sechs Kompetenzstufen (K1 bis K6) hierarchisch kategorisiert, wobei nach SITTE[2] jede niedrigere Kategorie jeweils ein Element der höheren ist. Die Kompetenzstufen können durch gezielte Verwendung von Verben, wie z.B. nach MEYER[3] in den Modulbeschreibungen formuliert und damit manifestiert werden.

| | | |
|---|---|---|
| K1 | Wissen | Wiedergabe von Wissen, Begriffen, Definitionen, Verfahren, Zusammenhängen, etc.<br>Typische Verben: *kennen, beschreiben, darstellen, berichten, benennen* |
| K2 | Verstehen | Wissen mit eigenen Worten sinnerhaltend umformen und in eigenen Worten wiedergeben können.<br>Typische Verben: *interpretieren, definieren, formulieren, ableiten* |
| K3 | Anwendung | In konkreten Situationen Regeln, Methoden oder Berechnungsverfahren anwenden können<br>T*ypische Verben: durchführen, berechnen, planen, gestalten, erarbeiten* |
| K4 | Analyse | Problemstellungen in Elemente zerlegen können, um dann anhand eines Vergleiches, Prinzipien, Strukturen sowie Gemeinsamkeiten oder Widersprüche herausarbeiten zu können<br>Typische Verben: *auswählen, einteilen, untersuchen, vergleichen, analysieren* |
| K5 | Synthese | Einzelne Elemente zu einem Ganzen, Neuen zusammenfügen<br>Typische Verben: *entwerfen, zuordnen, konzipieren, konstruieren, entwickeln* |
| K6 | Beurteilen | Abgabe eines bewertenden Urteils<br>Typische Verben: *beurteilen, entscheiden, begründen, bewerten, klassifizieren* |

[1] BLOOM, B. S. — Taxonomie von Lernzielen im kognitiven Bereich, Beltz Verlag, Weinheim, 1976[1]
[2] SITTE, W. & WOHLSCHLÄGL, H. — Beiträge zur Didaktik des „Geographie und Wirtschaftskunde“-Unterrichts. (=Materialien zur Didaktik der Geographie und Wirtschaftskunde, Bd. 16), Wien, 2004
[3] MEYER, R. — http://www.arbowis.ch/material/lp/Lehren/Zielformulierung_Verben.pdf, Stand Juli 2012

# 4 Kompetenzstufen

| Modulname | Kompetenzstufen | | | | | |
|---|---|---|---|---|---|---|
| | K1 | K2 | K3 | K4 | K5 | K6 |
| Advanced BodyEngineering and Lightweight Design | | | | | | |
| Vehicle Concepts and Integration | | | | | | |
| Vehicle Dynamics and Automotive Chassis | | | | | | |
| Vehicle Electronics and Communication | | | | | | |
| Advanced Combustion Engines | | | | | | |
| FEA in Body Engineering | | | | | | |
| NVH Systems Engineering | | | | | | |
| Advanced Vehicle Safety | | | | | | |
| Numerical Methods | | | | | | |
| Advanced Materials - Selection and Life Cycle Assessment | | | | | | |
| Advanced Thermodynamics | | | | | | |
| Control System Design | | | | | | |
| Modelling of Multi-Body Systems | | | | | | |
| Optimal Control and Estimation | | | | | | |
| Statistical Optimization | | | | | | |
| Structural Durability | | | | | | |
| Vehicle Dynamics Simulation | | | | | | |
| Automotive Manufacturing Processes | | | | | | |
| Corporate Management | | | | | | |
| Digital Factory | | | | | | |
| Legal Requirements and Homologation | | | | | | |
| Sustainability | | | | | | |
| Engineering Ethics | | | | | | |
| Automotive Supply Chain Management | | | | | | |
| Leadership Application | | | | | | |
| Component Design, Materials and Manufacture | | | | | | |
| Vehicle Dynamics Simulation | | | | | | |
| Virtual Reality | | | | | | |
| Cost-Efficient Product Design | | | | | | |
| Driver Assistance Systems | | | | | | |
| Mobility Concepts | | | | | | |
| Technology of Material Flow and Robotics | | | | | | |
| Master Thesis | | | | | | |

# 5 Description of Modules

| Technology Arts Sciences TH Köln | Advanced Body Engineering and Lightweight Design | ABE |
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|---|---|
| **Credits** | 6 |
| **Designated Degree** | Master of Science Automotive Engineering, 1. Semester |
| **Lecturer** | Prof. Dr.-Ing. Frank Herrmann |
| **Responsible** | Prof. Dr.-Ing. Frank Herrmann |
| **Content** | • Lightweight design of vehicle structures<br>• Properties and applications of metals and fibre reinforced plastics for automotive structures<br>• Advanced mechanics focusing on failure criteria and modes<br>• Structural analysis (FEM) in vehicle structure development |
| **Learning Outcome** | The students are able to<br>• carry out basic engineering designs of vehicle lightweight structures,<br>• compare and evaluate design solutions for vehicle structures regarding light weight design, material application and mechanical properties,<br>• analyse and interpret structural analysis (FEM) results,<br>• apply specific knowledge of advanced body materials and mechanical methods within the development process of vehicle structures. |
| **Teaching Methods** | • Literature based self studies of advanced materials and mechanics<br>• Lectures with integrated excercises |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: English/German |
| **Examination** | Written examination (90 min) |
| **Prerequisites** | TH Köln, BEng Fahrzeugtechnik, Lecture Karosserie or adequate knowledge in Body Engineering |
| **Recommended Literature** | *Braess/Seiffert:* Handbuch der Kraftfahrzeugtechnik<br>*Grabner/Nothhaft:* Konstruieren von Pkw-Karosserien<br>*Dubbel:* Taschenbuch für den Maschinenbau<br>*Kessel, Fröhling:* Technische Mechanik<br>*Chakrabarty:* Applied Plasticity<br>*Ostermann:* Anwendungstechnologie Aluminium<br>*Schürmann:* Konstruieren mit Faser-Kunststoff-Verbunden<br>An updated list of literature will be given in the lectures. |
| **Workload** | *Pre-module preparation:* *12 h*<br>*Teaching lessons (5 SWS):* *80 h*<br>*Self studies:* *48 h*<br>*Preparation for examination:* *40 h*<br>*In total:* ***180 h*** |

| | | |
|---|---|---|
| Technology Arts Sciences TH Köln | Vehicle Concepts and Integration | VCI |

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|---|---|
| **Credits** | 6 |
| **Designated Degree** | Master of Science Automotive Engineering, 1. Semester |
| **Lecturer** | Prof. Dr.-Ing. Michael Frantzen |
| **Responsible** | Prof. Dr.-Ing. Michael Frantzen |

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|---|---|
| **Content** | • Introduction to vehicle concepts<br>• History of vehicle building, challenges for new vehicle concepts<br>• Introduction to vehicle design, ergonomics & package<br>• Interaction between drive train variants, body and chassis (Integration)<br>• Innovation management, research, development processes<br>• Limits of mobility, the (auto-) mobile future |
| **Learning Outcome** | The students are able to<br>• sketch,<br>• basically design and layout,<br>• classify,<br>• judge and select new types of vehicles in line with customer wants and market needs.<br>This will be taught problem based, in a simulated project environment and with the help of innovation-, research- and project management-tools, in combination with team work and individual tasks.<br>The students justify, defend, advertise and champion their ideas of new vehicle concepts for future demands and continued improvements of sustainable mobility concepts for a changing world and society, by a detailed presentation of the research and design process outcome, together with a convincing marketing concept.<br>In the final documentation the above mentioned is documented, illustrated and filed, comparing existing vehicle concepts to the proposed concepts in terms of day-by-day usability, sustainability, propulsion engine, chassis- and body-concepts and expected costs, based on the proposed usage. |
| **Teaching Methods** | • Lectures with problem based integrated exercises (ProfiL$^2$)<br>• Presentations from industry and academic partners<br>• Project work in small teams, homework, practical seminar work<br>• Simulation of development systems and processes<br>• Practical work, excursions and presentations (incl. e.g. “elevator pitch”) |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material and some exercise: English |
| **Examination** | Active participation in seminary work, project work, project documentation, excursions and presentation of project outcome (individually and in teams) |
| **Prerequisites** | No specific requirements |
| **Recommended Literature** | *Braess/Seifert:* Vieweg Handbuch Kraftfahrzeugtechnik (Vieweg)<br>*Bosch:* Kraftfahrtechnisches Handbuch (Vieweg+Teubner) |

| **Workload** | | | *L* | *E* | *P/Project* |
|---|---|---|---|---|---|
| | *Teaching lessons:* | ***48 h*** | *32 h* | *16 h* | |
| | *Pre- and afterwork:* | ***72 h*** | | | *72 h* |
| | *Test report:* | ***24 h*** | *24 h* | | |
| | *Preparation for examination:* | ***36 h*** | | | *36 h* |
| | *In total:* | ***180 h*** | | | |

| Technology Arts Sciences TH Köln | Vehicle Dynamics and Automotive Chassis | VDAC |
|---|---|---|

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|---|---|
| **Credits** | 6 |
| **Designated Degree** | Master of Science Automotive Engineering, 1. Semester |
| **Lecturer** | Prof. Dr.-Ing. Jürgen W. Betzler |
| **Responsible** | Prof. Dr.-Ing. Jürgen W. Betzler |
| **Content** | Methods to describe and evaluate vehicle motions; Identification of driver-oriented, function-based and legal demands on vehicle dynamics, suspension subsystems and components with respect to longitudinal dynamics (braking). |
| **Learning Outcome** | The students are able to<br>• define and describe driver-oriented demands on performance of vehicle, key suspension subsystems and components,<br>• analyze practical brake system problems and develop solutions,<br>• compare, conclude and judge developed technical solutions based on driver and legal demands. |
| **Teaching Methods** | • Lectures (including external experts)<br>• Seminars given by student teams including discussions<br>Team based and problem focused development of solutions |
| **Practical Laboratory Work** | Using rigs to measure the properties of vehicle/suspension systems and doing an analysis of their behavior. |
| **Language** | • Teaching: German (summary: English)<br>• Teaching material: German/English |
| **Examination** | Written examination (90 min), presentations and project documentation |
| **Prerequisites** | Vehicle dynamics, basics of automotive chassis |
| **Recommended Literature** | *Breuer, B.; Bill, K.-H.:* Bremsenhandbuch, Heidelberg-, SpringerVerlag, 4. Aufl, 2013 *Robert Bosch GmbH:* KraftfahrzeugtechnischesTaschenbuch, Heideberg, Springer- Verlag, 28. Aufl. 2014<br>*Haken, K.-L.,* Grundlagen der Kraftfahrtzeugtechnik, München, Carl Hanser Verlag, 4. Aufl. 2015<br>*Heißing, Bernd, Ersoy, Metin, Gies, Stefan (Hrsg.):* Fahrwerkhandbuch, Heidelberg, Springer-Verlag, 4. Aufl, 2013<br>*Reimpell, J.; Betzler, J.W.:* Fahrwerktechnik: Grundlagen 5. Aufl. Würzburg, Vogel Buchverlag, 2005<br>*Reimpell, J.; Stoll, H.; Betzler, J.:* The Automotive Chassis: Engineering Proncíples, Lodon, Butterworth and Heinemann, 2000<br>*Winner, H., Hakuli, S., Lotz, F., Singer, C. (Hrsg.):* Handbuch Fahrerassistenzsysteme, Springer Verlag Heidelberg, 3. Aufl. 2015<br>Add. literature and legal regulations specified in the lectures. |

| **Workload** | | | | | |
|---|---|---|---|---|---|
| | | | *L* | *E* | *P/Project* |
| | *Teaching lessons incl. self studies, presentations:* | ***104 h*** | *45 h* | *15 h* | *44 h* |
| | *Test report:* | ***36 h*** | | | |
| | *Preparation for examination:* | ***40 h*** | | | |
| | *In total:* | ***180 h*** | | | |

| Technology Arts Sciences TH Köln | Vehicle Electronics and Communication | VEC |
|---|---|---|

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|---|---|
| **Credits** | 6 |
| **Designated Degree** | Master of Science Automotive Engineering, 1. Semester |
| **Lecturer** | Prof. Dr.-Ing. Toni Viscido, Prof. Dr.-Ing. Ulf-Marko Gundlach |
| **Responsible** | Prof. Dr.-Ing. Toni Viscido, Prof. Dr.-Ing. Ulf-Marko Gundlach |
| **Content** | • Electronic systems in vehicles<br>• Automotive data technology<br>• X-by-wire systems<br>• Bus-systems<br>• EMV/EMS<br>• Electrical power supply<br>• Electronic drives and hybrid systems |
| **Learning Outcome** | The students are able to<br>• describe automotive electronic control systems with respect to state of the art,<br>• identify future trends,<br>• explain possible limits and failures behaviour of electronic components. |
| **Teaching Methods** | • Lectures<br>• Seminars |
| **Practical Laboratory Work** | Electrical power control, power generators, CAN-bus functionality, bus behaviour, controller/memory behaviour |
| **Language** | German/English |
| **Examination** | Written examination |
| **Prerequisites** | Fundamental knowledge of vehicle electrics, physics, combustion engines, vehicle dynamics and automotive chassis, numerical methods in engineering sciences, mechatronic system for automotive applications |
| **Recommended Literature** | *Streichert, T.; Traub, M.:* Elektrik/Elektronik-Architekturen im Kraftfahrzeug. VDI/Springer, 2012<br>*Reif, K.:* Batterien, Bordnetze und Vernetzung. Vieweg und Teubner, 2010 |

| **Workload** | | | *L* | *E* | *P/Project* |
|---|---|---|---|---|---|
| | *Teaching lessons:* | ***90 h*** | *60 h* | *20 h* | *10 h* |
| | *Preparation for courses and examination:* | ***90 h*** | | | |
| | *In total:* | ***180 h*** | | | |

| Technology Arts Sciences TH Köln | Advanced Combustion Engines | ACE |
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|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Kai-Uwe Münch |
| **Responsible** | Prof. Dr.-Ing. Kai-Uwe Münch |
| **Content** | • Supercharging of engines (turbocharging, resonance charging, variable length intake manifolds, compressors)<br>• Downsizing<br>• Exhaust emissions and emission control systems (forces inside the engine, mass balancing)<br>• Engine torque<br>• Torque fluctuations (rotational vibrations)<br>• Hybridization of the power train |
| **Learning Outcome** | The students are able to<br>• describe and discriminate the several systems of supercharging in function and basic knowledge,<br>• describe and explain the coherences and technology of the piston engine including using the theoretical background,<br>• explain and analyse the gas- and mass forces of the engine,<br>• analyse and understand of hybridization advantages of the Power train,<br>• learn about alternative Fuels and sources (illustrate the methods of mass balancing, design a mass balancing, explain and analyse torque fluctuations and its influence to the power train). |
| **Teaching Methods** | • Lecture<br>• Exercises<br>• Presentation<br>• (Practical training on engines in small groups) |
| **Practical Laboratory Work** | Measurement of in-cylinder pressure versus crank-angle and calculation of torque and engine speed fluctuations |
| **Language** | • Teaching: German<br>• Teaching material: English |
| **Examination** | Written examination (120 min) |
| **Prerequisites** | Physics, chemistry, thermodynamics, mathematics, statics, dynamics, material science, electrical engineering, vehicle driving mechanics |
| **Recommended Literature** | Internal Combustion Engine Handbook, SAE<br>*Robert Bosch GmbH:* Automotive Handbook, Düsseldorf, VDI Verlag, 1991<br>SAE technical Papers for up-to-date publications |

| **Workload** | | | *L* | *E* | *P/Project* |
|---|---|---|---|---|---|
| | *Teaching lessons:* | ***54 h*** | *32 h* | *14 h* | *6 h* |
| | *Self studies:* | ***46 h*** | | | |
| | *Preparation for examination:* | ***20 h*** | | | |
| | *In total:* | ***120 h*** | | | |

| Technology Arts Sciences TH Köln | FEA in Body Engineering | FEx |
|---|---|---|

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|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Frank Herrmann |
| **Responsible** | Prof. Dr.-Ing. Frank Herrmann |
| **Content** | • Nonlinearities in FEM: material plasticity, nonlinear geometry and contact<br>• Crush and crash of vehicle substructures<br>• Quasistatic implicit FEM<br>• Dynamic explicit FEM<br>• Material failure criteria and structural failure modes |
| **Learning Outcome** | The students are able to<br>• understand metal plasticity and behaviour of vehicle structures beyond material yielding and<br>• apply nonlinear FEM to typical crush and crash problems of automotive structures. |
| **Teaching Methods** | Lectures with computer exercises |
| **Practical Laboratory Work** | Application of FEM code Abaqus at the computer lab of the faculty |
| **Language** | • Teaching: German<br>• Teaching material: English/German |
| **Examination** | Written examination, FEM problem to be solved on the computer (270 min) |
| **Prerequisites** | TH Köln, BEng Fahrzeugtechnik, Lecture FEM Leichtbau |
| **Recommended Literature** | Abaqus documentation<br>Abaqus tutorial<br>Script TH Köln, BEng Fahrzeugtechnik, Vorlesung FEM Leichtbau |
| **Workload** | *Teaching lessons (3 SWS):* *4 h*<br>*Computer lab (3 SWS)* *44 h*<br>*Self studies at Computer lab:* *48 h*<br>*Preparation for examination:* *40 h*<br>*In total:* ***120 h*** |

| Technology Arts Sciences TH Köln | NVH Systems Engineering | NVH |
|---|---|---|

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|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Axel Faßbender, Prof. Dr.-Ing. Rainer Haas |
| **Responsible** | Prof. Dr.-Ing. Axel Faßbender, Prof. Dr.-Ing. Rainer Haas |
| **Content** | • Advanced mechanical vibrations<br>• advanced acoustics<br>• advanced signal analysis<br>• hydraulics<br>• computer-based tools in NVH development |
| **Learning Outcome** | The students are able to<br>• can apply state-of-the-art process-oriented methodologies and tools in NVH development,<br>• are able to explain the scientific basics of mechanical vibrations, acoustics, signal analysis and hydraulic components and systems,<br>• are able to explain and apply the NVH peculiarities of computer-based tools like FEM, multibody, digital signal acquisition/analysis and hydraulic simulations,<br>• are capable to apply this know-how to automotive applications. |
| **Teaching Methods** | • Lecture with focus on NVH basics (75 % - mechanics, acoustics, signal analysis) and hydraulic in automotive systems (25 %)<br>• Case-study based project work with special focus e.g. on hydraulic applications or other state-of-the-art topics<br>• Use of e-learning system for distribution of course material and actual lecture notes |
| **Practical Laboratory Work** | Project work |
| **Language** | • Teaching: German<br>• Teaching materials: English<br>• Software: English |
| **Examination** | • Project work with documentation (60 %)<br>• Presentation and colloquium (40 %) |
| **Prerequisites** | Knowledge in "Fahrzeugschwingungen und - akustik" and "Grundlagenkenntnisse Hydraulik" (see Bachelor Fahrzeugtechnik) as recommendation |
| **Recommended Literature** | *Fahy, F.:* Sound and Structural Vibration - Radiation, Transmission and Response, London, Academic Press, 1998<br>*Freymann, R.:* Advanced Numerical and Experimental Methods in the Field of Vehicle Structural-Acoustics, Habilitationsschrift, TU-München, München, Hieronimus, 2000<br>*Newland, D.E.:* Random Vibrations, Spectral & Wavelet Analysis, Harlow, Langman, 1997<br>*Rao, S.:* Mechanical Vibrations, Singapore, Pearson Education, 2004<br>Further Literature see detailed reference list in script. |

| **Workload** | | | L | E | P/Project |
|---|---|---|---|---|---|
| | *Teaching lessons:* | ***32 h*** | *16 h* | *16 h* | |
| | *Self studies:* | ***88 h*** | | | *88 h* |
| | *In total:* | ***120 h*** | | | |

| Technology Arts Sciences TH Köln | Advanced Vehicle Safety | AVS |
|---|---|---|

| | |
|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Toni Viscido |
| **Responsible** | Prof. Dr.-Ing. Toni Viscido |

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|---|---|
| **Content** | • Principles of road and vehicle safety<br>• Vehicle safety systems and crashworthiness<br>• Active and passive safety<br>• Crash modes and structural design requirements<br>• Crash investigation, driver behavior and safety |
| **Learning Outcome** | The students are able to<br>• describe requirements to modern car design concerning safety,<br>• understand the critical issues concerning active and passive safety protection,<br>• understand the engineering solutions to protect humans inside and outside the vehicle in the event of a crash. |
| **Teaching Methods** | • Lectures<br>• Exercises |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching materials: German/English |
| **Examination** | Written examination |
| **Prerequisites** | Fundamental knowledge about car design and automotive engineering |
| **Recommended Literature** | Literature will be recommended relating to the individual subjects. |

| **Workload** | | | L | E | P/Project |
|---|---|---|---|---|---|
| | *Teaching lessons:* | ***48 h*** | *32 h* | *16 h* | |
| | *Self studies and preparation for examination:* | ***72 h*** | | | |
| | *In total:* | ***120 h*** | | | |

| Technology Arts Sciences TH Köln | Numerical Methods in Engineering Sciences | NM |
|---|---|---|

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|---|---|
| **Credits** | 6 |
| **Designated Degree** | Master of Science Automotive Engineering, 1. Semester |
| **Lecturer** | Prof. Dr. rer. nat. Georg Engelmann |
| **Responsible** | Prof. Dr. rer. nat. Georg Engelmann |

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|---|---|
| **Content** | Principles and methods of the main fields of scientific computing:<br>• e.g. solution of linear systems<br>• eigenvalue problems<br>• singular value decomposition<br>• interpolation, quadrature<br>• solution of initial value problems |
| **Learning Outcome** | The students are able to<br>• describe and explain the main numerical methods used in engineering sciences,<br>• judge the performance and limitations of these methods,<br>• choose and apply these methods correctly,<br>• write Matlab® programs to perform numerical tasks in engineering sciences,<br>• describe and explain the algorithms for the main numerical methods implemented in Matlab®. |
| **Teaching Methods** | • Seminaristic lectures<br>• Self studies to work out certain topics of the course<br>• Exercises and practical training |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: English |
| **Examination** | Written examination |
| **Prerequisites** | Good knowledge in linear algebra and analysis.<br>Good programming skills in Matlab®. |
| **Recommended Literature** | *C. Moler:* Numerical Computation with Matlab, SIAM 2004, Philadelphia (Download 2012: www.mathworks.de/moler, for introduction)<br>*A. Quarteroni, R. Sacco, P. Gervasio:* Scientific Computation with Matlab and Octave, Springer, Berlin, 2010<br>*Micheal T. Heath*: Scientific Computing – An introductionary survey, McGraw-Hill, Boston, international edition, 2005<br>*A. Quarteroni, R. Sacco, F. Salieri*: Numerical Mathematics, Springer 2007, New York<br>*G. Strang*: Introduction to Linear Algebra, Wellesley – Cambridge Press, Wellesley (Mass.), 2009<br>*L.N. Trefethen*: D. Bau III, Numerical Linear Algebra, SIAM 1997, Philadelphia<br>(Further literature will be given during the course.) |

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| **Workload** | *Teaching lessons (5 SWS):* | ***70 h*** |
| | *Self studies:*<br>*(including preparation for the exercises and practical trainings)* | ***70 h*** |
| | *Preparation for examination:* | ***40 h*** |
| | *In total:* | ***180h*** |

| Technology Arts Sciences TH Köln | Advanced Materials | AM |
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| **Credits** | 6 |
| **Designated Degree** | Master of Science Automotive Engineering, 1. Semester |
| **Lecturer** | Prof. Dr.-Ing. Peter Krug, Prof. Dr. rer. nat. Johannes Stollenwerk |
| **Responsible** | Prof. Dr.-Ing. Peter Krug |

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| **Content** | Advanced materials and manufacturing technologies with emphasis on automotive applications:<br>• material science<br>• materials selection methods<br>• light weight design<br>• primary production of materials<br>• sensor materials<br>• surface engineering<br>• production processes of components<br>• process analysis<br>• sustainability<br>• carbon footprint<br>• life cycle assessment |
| **Learning Outcome** | The students are able to<br>• explain and apply the physical, material and manufacturing aspects of modern materials,<br>• describe aspects of recycling and ecological auditing,<br>• explain and distinguish between surface engineering technologies to improve material properties and durability,<br>• illustrate and compare modern production processes,<br>• analyze complex requirement sets and to develop solution concepts,<br>• evolve material-related strategies for typical management issues,<br>• critically assess external strategies,<br>• practice team work for evolving strategies<br>• conduct complete life cycle assessment on specific, complex automotive components. |
| **Teaching Methods** | • Lectures and invited speakers from industry<br>• Home exercises (micro projects)<br>• Discussion (plenum or individual)<br>• Student´s presentations<br>• Excursion |
| **Practical Laboratory Work** | Demonstration of material processing in different labs. |
| **Language** | • English/German lecture notes and slides, German/English language |
| **Examination** | Written examination, oral presentation and colloquium |
| **Prerequisites** | Basics in material science, manufacturing technologies and economics.<br>Fundamentals in automotive engineering. |
| **Recommended Literature** | *Tipler:* Physics for scientists and engineers, Worth Publisher, Inc., New York, 1991<br>*Maissel, G.:* Handbook of thin film technology, McGraw-Hill. Inc., 1983<br>*Cebon, D; Ashby, M.:* Case studies in Materials Selection; Butterworth 1996<br>*Mikell, P., G.:* Fundamentals of modern manufacturing: Materials, Processes and Systems, 3rd edition, publisher: Wiley, 2006 |

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| **Workload** | *Teaching lessons (5 SWS):* | ***90 h*** |
| | *Pre- and afterwork:* | ***45h*** |
| | *Preparation for examination:* | ***45 h*** |
| | *In total:* | ***180 h*** |

| Technology Arts Sciences TH Köln | Advanced Thermodynamics | ATD |
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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Kai-Uwe Münch |
| **Responsible** | Prof. Dr.-Ing. Kai-Uwe Münch |
| **Content** | • Unsteady heat transfer<br>• humid air and air conditioning<br>• introduction in technical combustion (main focus on reciprocating engine com-bustion):<br>fuel atomization, mixture formation, ignition, premixed and diffusion combustion, emission generation mechanism |
| **Learning Outcome** | The students are able to<br>• explain the fundamentals in technical combustion, humid air and air conditioning,<br>• describe and explain convective heat transfer,<br>• describe and explain unsteady heat transfer phenomena. |
| **Teaching Methods** | • Lectures<br>• Exercise courses |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching materials: English / German |
| **Examination** | Written examination (60 min) |
| **Prerequisites** | Higher mathematics, basic lectures thermodynamics and fluid dynamics |
| **Recommended Literature** | *Kuo, K.K.:* Principles of combustion, Wiley & Sons, New York<br>*Baehr, H.D.:* Thermodynamik, Springer, Berlin, Heidelberg |

| **Workload** | | | *L* | *E* |
|---|---|---|---|---|
| | *Teaching lessons:* | ***60 h*** | *40 h* | *20 h* |
| | *incl.Self studies:* | ***30 h*** | | |
| | *Preparation for examination:* | ***72 h*** | | |
| | *In total:* | ***180 h*** | | |

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|---|---|---|
| Technology Arts Sciences TH Köln | Control System Design | CSD |

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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Hermann Henrichfreise |
| **Responsible** | Prof. Dr.-Ing. Hermann Henrichfreise |

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| **Content** | • Classical control for linear systems:<br>Assessment of stability in the frequency domain, poles and zeros in the closed control loop, demands on control systems, choice of the control structure, methods for determination of controller parameters, enhanced control structures<br>• Introduction to linear state-space control for single input/output systems:<br>Full state vector feedback regulator, regulator design by pole placement, controllability, reference- and disturbance-feedforward, state observer, duality of regulator and observer design, observability, disturbance estimation, separation principle |
| **Learning Outcome** | The students are able to<br>• describe and explain demands on and methods to design linear control systems in the Laplace and time domain,<br>• perform classical and state space control design for single input/output systems,<br>• classify and take advantage of different controller structures,<br>• independently continue their education using further literature. |
| **Teaching Methods** | • Seminaristic lectures<br>• Demonstration and explanation of programming examples<br>• Self-studies to work out certain topics of the course |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: lecture notes in German, programming examples in English |
| **Examination** | Oral or written examination |
| **Prerequisites** | Basic knowledge of control engineering |
| **Recommended Literature** | *O. Föllinger et. al.:* Regelungstechnik – Einführung in die Methoden und ihre Anwendung. 10. Auflage, Hüthig Buch Verlag 2008<br>*B. Friedland:* Control System Design – An Introduction to State-space methods. Dover Pubn Inc 2005<br>Further Literature see also the literature list at the lecture notes. |

**Workload**

| | | L | E | P/Project |
|---|---|---|---|---|
| *Teaching lessons (4SWS):* | ***60 h*** | *30 h* | *15 h* | *15 h* |
| *Pre- and afterwork:* | ***30 h*** | | | |
| *Preparation for examination:* | ***30 h*** | *30 h* | | |
| *In total:* | ***120 h*** | | | |

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| Technology Arts Sciences TH Köln | Modelling of Multi-Body Systems | MMS |

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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Hermann Henrichfreise |
| **Responsible** | Prof. Dr.-Ing. Hermann Henrichfreise |

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| **Content** | 3-dimensional multi-body systems:<br>• kinematics, kinetics (Newton-Euler and Lagrange formalism)<br>• nonlinear equations of motion<br>• linearization<br>• nonlinear and linear state-space representation<br>• coupling with actuators<br>• model analysis for linear equations of motion (response to initial conditions and stimuli, eigenvalues, eigenvectors, mode shapes, modal transformation of the equations of motion) |
| **Learning Outcome** | The students are able to<br>• describe, explain and apply formalisms for modelling of multi-body systems and their numerical implementation,<br>• augment the models with electric and hydraulic actuators,<br>• analyse linear multi-body system models by means of response, eigenvalues, eigenmodes,<br>• independently continue their education using further literature. |
| **Teaching Methods** | • Seminaristic lectures<br>• Demonstration and explanation of programming examples<br>• Self-studies to work out certain topics of the course |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: lecture notes in German, programming examples in English |
| **Examination** | Oral or written examination |
| **Prerequisites** | Basic knowledge in kinematics and kinetics,<br>Good programming skills in Matlab® |
| **Recommended Literature** | *W. Schielen, F. Eberhard:* Einführung in die Dynamik. Teubner Verlag Stuttgart 2004<br>*H. Parkus:* Mechanik der festen Körper. Springer-Verlag, Wien New York 1981<br>Further Literature see also the literature list at the lecture notes. |

| **Workload** | | | *L* | *E* | *P/Project* |
|---|---|---|---|---|---|
| | *Teaching lessons (4SWS):* | ***60 h*** | *30 h* | *15 h* | *15 h* |
| | *Pre- and afterwork:* | ***30 h*** | | | |
| | *Preparation for examination:* | ***30 h*** | ***30 h*** | | |
| | *In total:* | ***120 h*** | | | |

| Technology Arts Sciences TH Köln | Optimal Control and Estimation | OCE |
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|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Hermann Henrichfreise |
| **Responsible** | Prof. Dr.-Ing. Hermann Henrichfreise |
| **Content** | Linear, quadratic, Gaussian (LQG) state-space control:<br>• fundamentals of the analysis of stochastic signals<br>• linear quadratic regulator (LQR) design<br>• linear quadratic estimator (LQE) design<br>• plant model augmentations for reference- and disturbance feedforward and disturbance estimation<br>• robust implementation by loop transfer recovery (LTR)<br>• Tool-supported design and implementation of an optimal state-space control for an electromechanical positioning system |
| **Learning Outcome** | The students are able to<br>• apply advanced knowledge of state-space control systems with reference- and disturbance-feedforward,<br>• describe, explain and apply the design of optimal linear state-space control systems by means of optimizing quadratic cost functions for deterministic and stochastic stimuli,<br>• describe, explain and apply an approach for robust implementation,<br>• independently continue their education using further literature. |
| **Teaching Methods** | • Seminaristic lectures<br>• Demonstration and explanation of programming examples<br>• Self-studies to work out certain topics of the course<br>• Demonstration of application examples with laboratory test rigs |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: lecture notes in German, programming examples in English |
| **Examination** | Oral or written examination |
| **Prerequisites** | Good knowledge of the lecture control system design,<br>Good knowledge in linear algebra and analysis |
| **Recommended Literature** | *O. Föllinger et. al.:* Regelungstechnik – Einführung in die Methoden und ihre Anwendung. 10. Auflage, Hüthig Buch Verlag 2008<br>*B. Friedland:* Control System Design – An Introduction to State-space methods. Dover Pubn Inc 2005<br>Further Literature see also the literature list at the lecture notes. |

**Workload**

| | | L | E | P/Project |
|---|---|---|---|---|
| *Teaching lessons (4SWS):* | ***60 h*** | *30 h* | *15 h* | *15 h* |
| *Pre- and afterwork:* | ***30 h*** | | | |
| *Preparation for examination:* | ***30 h*** | *30 h* | | |
| *In total:* | ***120 h*** | | | |

| Technology Arts Sciences TH Köln | Statistical Optimization | SO |
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|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr. rer.nat.habil. Rainer Lenz |
| **Responsible** | Prof. Dr. rer.nat.habil. Rainer Lenz |
| **Content** | Principles and methods of the main fields of Statistical Optimization:<br>• e.g. Probability and statistics<br>• optimization methods<br>• workflow optimization<br>• selected application examples<br>• robust optimization<br>• optimization examples from the automotive engineering |
| **Learning Outcome** | The students are able to<br>• describe and explain the main methods of combinatorial optimization used in engineering sciences,<br>• judge the performance and limitations of these methods,<br>• choose and apply appropriate methods and/or approximation heuristics associated with their algorithmic representation,<br>• write programs within the R environment in order to perform elaborated statistical analysis. |
| **Teaching Methods** | • Seminaristic lectures<br>• Self studies to work out certain topics of the course<br>• Exercises and practical training |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: English |
| **Examination** | Written examination |
| **Prerequisites** | Good knowledge in linear algebra, analysis and descriptive statistics.<br>Basic programming skills |
| **Recommended Literature** | *E. Kreyszig:* Advanced Engineering Mathematics, John Wiley & Sons, INC., Asia, 2011<br>*A. Koop:* Lineare Optimierung, Spektrum – Akad. Verlag, Berlin 2008<br>*P. Ruge:* Das Ingenieurwissen: Mathematik und Statistik, Springer Verlag Berlin Heidelberg, 2014 |
| **Workload** | *Teaching lessons:* ***60 h***<br>*self studies (including preparation for the exercises and practical trainings):* ***30 h***<br>*Preparation for examination:* ***30 h***<br>*In total:* ***120 h*** |

| Technology Arts Sciences TH Köln | Structural Durability | SD |
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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Peter Krug |
| **Responsible** | Prof. Dr.-Ing. Peter Krug |

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| **Content** | • Fatigue in different materials<br>• structural durability<br>• failure mechanisms<br>• technical failures<br>• fracture mechanics<br>• influencing factors on strength and fracture behavior<br>• influence of tribology, corrosion and impact I on component´s lifetime |
| **Learning Outcome** | The students are able to<br>• explain different methods to improve structural durability,<br>• critically assess complex mechanical or environmental loadings of components and their impact on component´s failure,<br>• describe and explain the influencing factors on strength and fracture behavior,<br>• examine the durability of different materials and/or different treated material,<br>• identify failure mechanisms and predict components lifetime,<br>• analyze, compare and improve given material and design with respect with durability demands.<br>• read, to analyze and to draw right conclusions from journal papers on structural durability and component´s failure. |
| **Teaching Methods** | • Lectures<br>• Exercises<br>• Laboratory work<br>• Reading and discussion of relevant journal papers (plenum or individual)<br>• Oral presentation by students |
| **Practical Laboratory Work** | • Applying different methods to improve endurance limit<br>• Applying different testing methods to check effectiveness |
| **Language** | English lecture notes and slides, English language |
| **Examination** | Colloquium, oral presentation and written examination |
| **Prerequisites** | Materials science, mathematics, mechanical design, requirements and boundary conditions of automotive components in service |
| **Recommended Literature** | *Cebon, D.; Ashby, M.:* Case studies in Materials Selection; Butterworth 1996<br>*Haibach, E.:* Betriebsfestigkeit- Verfahren und Daten zur Bauteilberechnung, Springer 2006<br>*Schmitt-Thomas, K. G.:* Integrierte Schadenanalyse Technikgestaltung und das System des Versagens, Springer 2005 |

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| **Workload** | *Teaching lessons+ laboratory work:*<br>*Pre- and afterwork:*<br>*Preparation for examination:*<br>*In total:* | ***60 h***<br>***30 h***<br>***30 h***<br>***120 h*** |

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| Technology Arts Sciences TH Köln | Vehicle Dynamics Simulation | VDS |

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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Jürgen W. Betzler |
| **Responsible** | Prof. Dr.-Ing. Jürgen W. Betzler |

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| **Content** | Using CAE-tools to simulate the kinematics of suspension systems and of the vehicle motion.<br>The project results will be documented in a written report and presented by the students. |
| **Learning Outcome** | The students are able to<br>• define driver oriented demands on the performance of suspension systems and vehicles,<br>• analyze the properties of the suspension system and of the vehicle dynamics performance,<br>• identify problems and develop solutions,<br>• compare, conclude and judge developed technical solutions based on driver requirements. |
| **Teaching Methods** | • Seminars<br>• Team based problem focused development of solutions |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching : German (summary: English)<br>• Teaching material: German/English |
| **Examination** | Presentation, team report, written examination |
| **Prerequisites** | Vehicle dynamics, basics of automotive chassis, basics of CAE tools |
| **Recommended Literature** | *Robert Bosch GmbH:* KraftfahrzeugtechnischesTaschenbuch, Heideberg, Springer-Verlag, 28. Aufl. 2014<br>*Haken, K.-L.:* Grundlagen der Kraftfahrtzeugtechnik, München, Carl Hanser Verlag, 4. Aufl. 2015<br>*Heißing, Bernd, Ersoy, Metin, Gies, Stefan (Hrsg.):* Fahrwerkhandbuch, Heidelberg, Springer-Verlag, 4. Aufl, 2013<br>*Reimpell, J.; Betzler, J.W.:* Fahrwerktechnik: Grundlagen 5. Aufl. Würzburg, Vogel Buchverlag, 2005<br>*Reimpell, J.; Stoll, H.; Betzler, J.:* The Automotive Chassis: Engineering Pronciples, Lodon, Butterworth and Heinemann, 2000<br>Add. literature and legal regulations specified in the lectures. |

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| **Workload** | *Teaching lessons incl. project work:*<br>*Team report:*<br>*Preparation for examination:*<br>*In total:* | ***64 h***<br>***36 h***<br>***20 h***<br>***120 h*** |

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| Technology Arts Sciences TH Köln | Automotive Manufacturing Processes | AMP |

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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Christoph Hartl |
| **Responsible** | Prof. Dr.-Ing. Christoph Hartl |
| **Content** | Fundamentals and applications of manufacturing technologies and process chains used for manufacturing and processing of metallic and non-metallic materials (plastic components, technical glass, ceramics), and composite materials related to automotive production. |
| **Learning Outcome** | The students are able to<br>• evaluate suitable manufacturing methods and process chains for an industrial production of automotive components,<br>• analyse the feasibility of manufacturing methods and process chains,<br>• compare product costs, processing time and product quality of different production methods. |
| **Teaching Methods** | • Lectures<br>• Exercises |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German/English<br>• Teaching material: English |
| **Examination** | Written examination |
| **Prerequisites** | Knowledge in material sciences, engineering mechanics, physics and mathematics |
| **Recommended Literature** | *Groover, M.P.:* Principles of Modern Manufacturing, Wiley, 2013<br>(Further literature will be recommended relating to the individual subjects.) |

| **Workload** | | | *L* | *E* |
|---|---|---|---|---|
| | *Teaching lessons:* | ***48 h*** | *32 h* | *16 h* |
| | *Preparation for courses and examination:* | ***72 h*** | | |
| | *In total:* | ***120 h*** | | |

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|---|---|---|
| Technology Arts Sciences TH Köln | Corporate Management | CM |

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|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Michael Matoni |
| **Responsible** | Prof. Dr.-Ing. Michael Matoni |

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| **Content** | General Strategic Management:<br>• Process of leadership and executive function<br>• corporate strategy of OEM / international aspects of automotive business / marketing Management / management tools:<br>make -or-buy, flexibility, cots, business and operating models |
| **Learning Outcome** | The students are able to<br>• analyse specialities of strategic basics in automotive business,<br>• arrange the different strategic approach of international acting enterprises with fundamentals of marketing management,<br>• comply the techniques for analyzing industries and competitors,<br>• combine aspects for questioning to leadership,<br>• know how to synthesize strategic management situation. |
| **Teaching Methods** | • Lectures<br>• Exercises<br>• Project work / case studies<br>• Discussion (individual) |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: English |
| **Examination** | Written examination (120 min)<br>Successful participation to project is precondition for examination. |
| **Prerequisites** | Basics in Economics and Marketing |
| **Recommended Literature** | *Ebel, Hofer, Al-sibai:* Automotive Management, Springer Verlag 2003<br>*Clarke:* Automotive Production Systems and Standardisation, Physika Verlag, 2005<br>*Heneric:* Europe´s Auromotive Industry on the move, Physika Verlag, 2005 |

| **Workload** | | | |
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| | | | *L* |
| | *Teaching lessons (3 SWS):* | ***72 h*** | *72 h* |
| | *Pre- and afterwork:* | ***24 h*** | *24 h* |
| | *Preparation for examination:* | ***24 h*** | *24 h* |
| | *In total:* | ***120 h*** | |

| Technology Arts Sciences TH Köln | Digital Factory | DiFa |
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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Ralf Breede |
| **Responsible** | Prof. Dr.-Ing. Ralf Breede |
| **Content** | Methods and tools for digital planning and continuous optimization of industrial production environments with an emphasis on automotive production processes in terms of a digital factory. |
| **Learning Outcome** | The students are able to<br>• explain the fundamentals of a Digital Factory,<br>• understand and use methods and tools for digital process planning,<br>• illustrate and compare industrial production processes,<br>• describe and discuss modelling and simulation techniques<br>• analyze complex planning situations to develop solution concepts. |
| **Teaching Methods** | • Lectures<br>• Exercises |
| **Practical Laboratory Work** | Practical examples of manufacturing processes using 3D-Simulation tools |
| **Language** | • Teaching: German<br>• Teaching material: English |
| **Examination** | Written examination |
| **Prerequisites** | • Knowledge of production processes and techniques, production organization, manufacturing principles and automation<br>• Fundamentals of 3D-CAD/CAE-systems |
| **Recommended Literature** | *Bracht, U.; Geckler, D.; Wenzel, S.:* Digitale Fabrik - Methoden und Praxisbeispiele. Springer, 2011<br>*Kühn, W.:* Digitale Fabrik - Fabriksimulation für Produktionsplaner. Hanser, 2006<br>Further literature will be recommended relating to the subject within the lectures. |
| **Workload** | *Teaching lessons:* ***60 h***<br>*Pre- and afterwork:* ***30 h***<br>*Test report:* ***30 h***<br>*In total:* ***120 h*** |

| Technology Arts Sciences TH Köln | Legal Requirements and Homologation | LRH |
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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | N.N. |
| **Responsible** | Prof. Dr.-Ing. Michael Frantzen, , Prof. Dr.-Ing. Peter Krug |
| **Content** | The module is focused on processes, boundary conditions and regulations which have to be considered to certify the roadworthy of vehicles on global market. Selected country-specific standards and regulations which impact vehicle homologation will be highlighted. |
| **Learning Outcome** | The students are able to<br>• understand the basic core issues in global vehicle homologation,<br>• identify specific problem definitions related to the module content,<br>• practise specialisation. |
| **Teaching Methods** | • Lectures<br>• Exercises and case studies |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: German |
| **Examination** | Written examination |
| **Prerequisites** | No specific requirements |
| **Recommended Literature** | Literature will be recommended relating to the individual subjects. |
| **Workload** | *Teaching lessons:* ***48 h***<br>*Preparation for courses and examination::* ***72 h***<br>*In total:* ***120 h*** |

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|---|---|---|
| Technology Arts Sciences TH Köln | Sustainability | SUT |

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|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr. Semih Severengiz |
| **Responsible** | Prof. Dr. Semih Severengiz, Prof. Dr.-Ing. Peter Krug |
| **Content** | • Environmental issues within product development<br>• Detection of environmental requirements with the aid of scenario procedures<br>• Analysis and evaluation of technologies from environmental perspective<br>• Environmental innovations and trends in automotive engineering |
| **Learning Outcome** | The students are able to<br>• identify environmental issues in product design and manufacture for automotive components,<br>• apply scenario procedures to detect environmental requirements in component design and development,<br>• analyse and evaluate manufacturing technologies concerning their environmental impact,<br>• describe environmental innovations and trends in automotive engineering. |
| **Teaching Methods** | • Lectures<br>• Exercises |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material: German/English |
| **Examination** | Written examination |
| **Prerequisites** | No specific requirements |
| **Recommended Literature** | Literature will be recommended relating to the individual subjects. |

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| **Workload** | | | *L* | *E* |
| | *Teaching lessons:* | ***48 h*** | *32 h* | *16 h* |
| | *Preparation for courses and examination::* | ***72 h*** | | |
| | *In total:* | ***120 h*** | | |

| Technology Arts Sciences TH Köln | Engineering Ethics | EE |
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|---|---|
| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Dr. Hubertus Zilkens |
| **Responsible** | Dr. Hubertus Zilkens |
| **Content** | • Definition of the Terms Technology, Economy and Ethics – transdependency of the different disciplines<br>• History of the European sense of technological progress (we may as we can vs. we can what we may)<br>• Transfer of the classical cardinal virtues and vices to the industrial and business routines<br>• Ethics, social behavior and corporate social responsibility – the model of the Honorable Businessman<br>• Ethics and eligibility diagnostics (which ethical dispositions and cultural attributes should I earn to successfully obtain leading positions in a company) |
| **Learning Outcome** | The students are able to<br>• have deep knowledge about the historical progress of morals and values,<br>• recognize the effects of their technical opus and can estimate the impact concerning society and sustainability,<br>• enjoy an extensive transdisciplinary education in the fields of ethics and history,<br>• gain orientation regarding their personal character traits and can align themselves in a social and individual sense of ethics,<br>• are able to practically apply their knowledge, e.g. in the field of leadership and business,<br>• add an extensive humanistic education to their technical competences. |
| **Teaching Methods** | Lecture, interactive discussions and short presentations from the students |
| **Practical Laboratory Work** | - |
| **Language** | German |
| **Examination** | Written examination (120 min) |
| **Prerequisites** | - |
| **Recommended Literature** | To be given during lectures. |
| **Workload** | *Teaching lessons:* ***64 h***<br>*Pre- and afterwork* ***36 h***<br>*Preparation for examination::* ***20 h***<br>*In total:* ***120 h*** |

| Technology Arts Sciences TH Köln | Automotive Supply Chain Management | ASCM |
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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 1. Semester |
| **Lecturer** | Prof. Dr. rer. pol. Helmut Schulte Herbrüggen |
| **Responsible** | Prof. Dr. rer. pol. Helmut Schulte Herbrüggen |
| **Content** | • Basics and definitions of Automotive Supply Chain Management Systems<br>• Goals and Strategies of Automotive Supply Chain Management Systems<br>• SCOR (Supply Chain Operations Reference) – Model<br>• Analysis and Design focussing on LEAN Automotive Supply Chains through prevention of waste, minimization and optimization of interfaces, standardization and modularization, integrated quality assurance, transparency and visualization concepts, motivation concepts, internationalization, network design, partnering, sustainability and continuous improvement / Kaizen)<br>• Supply Chain Collaboration in order to reduce bullwhip effects and support logistical integration of Automotive Supply Chain resources<br>• Controlling of Automotive Supply Chain Systems<br>• Automotive Supply Chain Event and Risk Management<br>• Innovative and integrative concepts for Automotive Supply Chain Management Systems |
| **Learning Outcome** | After having successfully participated in this lecture students are able to<br>• define, discuss, assess, evaluate, compare and rank challenges through individualization of customers' wishes as well as of today's automotive markets through globalization of demand and supply.<br>• record, illustrate, discuss, analyse and create the matching optimized structures and processes for supply chain and logistical systems.<br>• compose carefully balanced logistical automotive supply chain networks that provide customers with Just-In-Sequence solutions in order to meet the high expectations of shareholders and stakeholders.<br>• formulate and combine integrative strategies, systems and skills of an enterprise as well as those of its supply chain partners in order to be able to flexibly respond to the frequently changing customer requirements in different markets.<br>• identify, choose and combine concepts of rationalization through scheduling and combining elimination of waste (Lean Management) and organizing Total Quality Management (TQM) and Total Productive Maintenance (TPM).<br>• professionally set up early warning and benchmarking systems simultaneously in order to meet customer expectations better than competitors and combine and schedule corresponding instruments to realize best practices. |
| **Teaching Methods** | • Lectures<br>• Exercises |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: English<br>• Teaching Material: English |
| **Examination** | Written examination<br>(90 min; dictionary without any comments allowed: English-English, English-German and German-English) |
| **Prerequisites** | Basic knowledge of Logistics and Supply Chain Management is recommended. |
| **Recommended Literature** | *Harrison, A./ van Hoek, R.:* Logistics Management & Strategy – Competing Through the Supply Chain, latest ed., Harlow: Pearson Education<br><br>*Russell, R.S./ Taylor, R.W.):* Operations and Supply Chain Management, International Student Version, latest ed., John Wiley & Sons Singapore Pte. Ltd. *Mangan, John/ Lalwani, Chandra/ Butcher, Tim/ Javadpour, Roya:* Global Logistics and Supply Chain Management, latest ed., Chichester: John Wiley & Sons Ltd. |

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| | *Coyle, John J./ Langley, C. John/ Novack, Robert A./ Gibson, Brian J.:* Managing Supply Chains: A Logistics Perspective, latest international ed., Canada: South Western, Cengage Learning<br><br>*Bowersox, Donald, J./ Closs, David, J./ Cooper, M. Bixby/ Bowersox, John C.:* Supply Chain Logistics Management; latest international ed., Singapore: McGraw Hill Further course related literature (books, journals or articles) may be indicated during the course. |

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| **Workload** | | | *L* | *E* |
| | *Teaching lessons (4 SWS):* | ***60 h*** | *30 h* | *30 h* |
| | *Pre- and afterwork:* | ***30 h*** | | |
| | *Preparation for examination:* | ***30 h*** | | |
| | *In total:* | ***120 h*** | | |

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| Technology Arts Sciences TH Köln | Leadership Application | LSA |

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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | |
| **Responsible** | |

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| **Content** | Based on an introduction to fundamental skills and philosophies of leadership, student teams of the master course will manage and supervise student teams of the bachelor course “Fahrzeugtechnik” in their compulsory module “Projekte”.<br>The module references numerous basic skills that leaders have to master in managing positions. These skills are practiced throughout this module and the students will be able to assess their personal leadership qualities and develop a plan to enhance their leadership potential. The project results will be documented in a written report and presented by the students within the frame of the Scientific and Interdisciplinary Seminar. |
| **Learning Outcome** | The students are able to<br>• apply methods for personnel management and project management,<br>• analyse a project status and prepare decisions,<br>• solve problems related to team work based technical projects. |
| **Teaching Methods** | • Introducing lecture<br>• Guided independent study |
| **Practical Laboratory Work** | According to the selected subject |
| **Language** | • Teaching: German/English<br>• Teaching material: German/English |
| **Examination** | Assessment of written report;<br>Assessment of presentation |
| **Prerequisites** | Fundamental knowledge according to the selected technical subject and fundamental knowledge in management methods |
| **Recommended Literature** | According to the selected subject |

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| **Workload** | *Teaching lessons (4 SWS):*<br>*Guided independent study:*<br>*Report preparation:*<br>*Preparation of presentation:*<br>*In total:* | ***10 h***<br>***50 h***<br>***40 h***<br>***20 h***<br>***120 h*** |

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| Technology Arts Sciences TH Köln | Component Design, Materials and Manufacture | CDMM |

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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Peter Krug |
| **Responsible** | Prof. Dr.-Ing. Peter Krug |

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| **Content** | Tracing the manufacturing process of typical automotive components starting with definition of requirements and constraints, designing the component, manipulating materials´ properties during the manufacturing process, quality control.<br>The project results will be documented in a written report and presented by the students within the frame of the Scientific and Interdisciplinary Seminar (Scientific Engineering Project). |
| **Learning Outcome** | The students are able to<br>• transfer requirements to adequate component design,<br>• apply their knowledge about materials and manufacturing to derive manufacturing strategies from component design and requirements in service,<br>• prepare a precise production plan by combining materials treatment and manufacturing methods and formulate a bill of material,<br>• analyze critical production steps and evolve back up strategies,<br>• conduct the scheduled manufacturing process,<br>• control the manufacturing process with regard to the required quality and design/process changes,<br>• formulate and apply appropriate quality checks to assure operational reliability of the manufactured component,<br>• assess critical the manufactured part and the manufacturing process (including planning),<br>• analyze, and compare the achieved results with real parts and processes (component based or literature based),<br>• summarize the whole process, identify consistencies and inconsistencies, advantages and disadvantages,<br>• rework the whole production plan based on the experience they made or derived during the project. |
| **Teaching Methods** | • Project based learning with lectures, laboratory work, oral presentation by students<br>• Presentation of relevant manufacturers<br>• Excursion to manufacturing companies |
| **Practical Laboratory Work** | • Manufacturing process and materials treatment<br>• Materials` and components` testing |
| **Language** | • English lecture notes and slides<br>• English language |
| **Examination** | Colloquium, Oral presentation |
| **Prerequisites** | Materials science, mathematics, mechanical design, requirements and boundary conditions of automotive components in service |
| **Recommended Literature** | *J. Lesko; Industrial Design:* Materials and Manufacturing Guide<br>*Miltiadis A. Boboulos:* Manufacturing Processes and Materials: Exercises<br>*R. Creese:* Introduction to Manufacturing Processes and Materials<br>*M. P. Groover;* Fundamentals of Modern Manufacturing: Materials, Processes, and Systems |

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| **Workload** | *Teaching lessons+ laboratory work:*<br>*Pre- and afterwork:*<br>*Preparation for examination:*<br><br>*In total:* | ***60 h***<br>***30 h***<br>***30 h***<br><br>***120 h*** |

| Technology Arts Sciences TH Köln | Virtual Reality | VR |
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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Christoph Ruschitzka |
| **Responsible** | Prof. Dr.-Ing. Christoph Ruschitzka |

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| **Content** | • Terms and definitions, history of virtual reality<br>• Input-devices:<br>dots of freedom, tracking methods, finger-tracking, eye-tracking, optical & mechanical devices<br>• Output-devices:<br>stereoscopy, visualization hardware (Desktop-VR, HMDs, HoloBench, Powerwall, CAVE), haptic devices<br>• Realtime aspects:<br>latency, collision detection, rendering methods<br>• Virtual worlds:<br>Human-Computer-Interaction, selection, navigation and manipulation<br>• Industrial software solutions:<br>engineering software tools, visualization tools, development tools, vr-frameworks<br>The project results will be documented in a written report and presented by the students within the frame of the Scientific and Interdisciplinary Seminar (Scientific Engineering Project). |
| **Learning Outcome** | The students are able to<br>• use different simulation software toolkits,<br>• project virtual environments,<br>• design virtual engineering sessions and visualization studies,<br>• coordinate collaborative vr-sessions,<br>• decide between different hard- and software-vr-solutions. |
| **Teaching Methods** | • Lectures and practical exercises using different VR-Systems<br>• Project |
| **Practical Laboratory Work** | Use of different VR-Tools for engineering and photorealistic visualization, e.g. ESI VDP, 3DEXcite Delta/Gen, COVISE, VTK;<br>Use of numerous vr-hardware solutions, e.g. stereoscopic Desktop-VR, Head Mounted Displays (HMD), Powerwalls, tracking systems, flystick |
| **Language** | • Teaching: German<br>• Teaching materials, documentations, software: English/German |
| **Examination** | Report & presentation |
| **Prerequisites** | Previous knowledge of various CAD-&CAE-Tools (Catia, NX, ABAQUS, HyperWorks, …) and experiences in programming software tools are helpful. |
| **Recommended Literature** | *Gutiérrez, Vexo, Thalmann:* Stepping into Virtual Reality, Springer Verlag London, 2008<br>*Dörner, Broll, Grimm, Jung:* Virtual und Augmented Reality (VR/AR) – Grundlagen und Methoden der virtuellen und augmentierten Realität, Springer Verlag Berlin Heidelberg, 2013<br>*Brill:* Virtuelle Realität (Informatik im Fokus), Springer Verlag Berlin Heidelberg, 2009<br>*Hausstädler:* Der Einsatz von Virtual Reality in der Praxis, Rhombos Verlag, 2010 |

| **Workload** | | | *L* | *E* | *P* |
|---|---|---|---|---|---|
| | *Teaching lessons:* | ***64 h*** | *8 h* | *8h* | *48 h* |
| | *Pre- and afterwork**:*** | ***24 h*** | | | *24 h* |
| | *Presentation and report:* | ***32 h*** | | | *32 h* |
| | *In total:* | ***120 h*** | | | |

| Technology Arts Sciences TH Köln | Cost-Efficient Product Design | CEPD |
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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Alexander Stekolschik |
| **Responsible** | Prof. Dr.-Ing. Alexander Stekolschik |

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| **Content** | Projects to different topics regarding cost-efficient product design, examples:<br>• Product Lifecycle, Product types<br>• Cost management for Product Development<br>• Target cost oriented Product Development, cost drivers<br>• Influencing product life cycle costs<br>• Factors and procedures for Lean Product Design<br>• Product variant management<br>• Influence of tools in Product Development<br>• Time to market<br>The project results will be documented in a written report and presented by the students within the frame of the Scientific and Interdisciplinary Seminar (Team based Engineering Project). |
| **Learning Outcome** | Depending on the detailed project topic students<br>• can analyze and breakdown product life cycle costs,<br>• can identify requirements on cost-efficient products,<br>• can apply methods of target costing to new products,<br>• are capable of analyzing product properties influencing costs,<br>• can relate different product related factors to manufacturing costs,<br>• are capable of defining product structure and product variants. |
| **Teaching Methods** | • Workshops<br>• Project work<br>• Presentations and written reports |
| **Practical Laboratory Work** | Engineering design parametric studies in the computer laboratory, CAD Design |
| **Language** | • Teaching: German, English on request<br>• Teaching material: German, English on request |
| **Examination** | Project report and project presentation |
| **Prerequisites** | Basic knowledge in Engineering Product Design / Product Development |
| **Recommended Literature** | *Hundal, M.; Ehrlenspiel, K.; Kiewert, A.; Lindemann, U.:* Cost-Efficient Design |

| **Workload** | | | *L* | *E* | *P* |
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| | *Teaching lessons:* | ***64 h*** | *8 h* | *8h* | *48 h* |
| | *Pre- and afterwork:* | ***36 h*** | | | *36 h* |
| | *Preparation for examination:* | ***20 h*** | | | *20 h* |
| | *In total:* | ***120 h*** | | | |

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| Technology Arts Sciences TH Köln | Driver Assistance Systems | DAS |

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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Tom Tiltmann |
| **Responsible** | Prof. Dr.-Ing. Tom Tiltmann |
| **Content** | • Classification and different types of DAS<br>• Technical requirements for DAS<br>• Implementation of DAS using the Robot Operating System<br>• Testing methods and evaluation of DAS<br>• Team based engineering project implementing DAS on a RC model |
| **Learning Outcome** | The students are able to<br>• explain classes and types of driver assistance systems,<br>• identify technical requirements concerning implementation of driver assistance in modern vehicles,<br>• understand the operation mode of essential driver assistance systems. |
| **Teaching Methods** | • Fundamentals workshops (groups of 2)<br>• Team based engineering project (groups of 2)<br>• Oral presentation (15 min.) and written report (10-15 pp.)<br>• Technical Coaching |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German, English<br>• Teaching material: German, English |
| **Examination** | Project report and project presentation |
| **Prerequisites** | Knowledge about vehicle concepts and integration |
| **Recommended Literature** | *Kramer, F.:* Integrale Sicherheit von Kraftfahrzeugen. Springer, 2013<br>*Winner, H.; Hakuli, S.; Wolf, G.:* Handbuch Fahrerassistenzsysteme. Vieweg-Teub-ner, 2012 |
| **Workload** | *Guided independent study:* ***40 h***<br>*Report preparation:* ***60 h***<br>*Preparation of presentation:* ***20 h***<br>*In total:* ***120 h*** |

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| Technology Arts Sciences TH Köln | Mobility Concepts | MC |

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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Michael Frantzen |
| **Responsible** | Prof. Dr.-Ing. Michael Frantzen |

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| **Content** | • Introduction to traffic management<br>• Existing alternative mobility concepts<br>• Special innovative vehicles and vehicle concepts for new models of traffic<br>• Future mobility<br>The project results will be documented in a written report and presented by the students within the frame of the Scientific and Interdisciplinary Seminar. |
| **Learning Outcome** | The students are able to<br>• sketch, basically design and layout,<br>• classify, judge and select new mobility concepts in line with customer wants and market needs.<br>This will be taught problem based, in a simulated project environment in combination with team work or individual tasks.<br>The students justify, defend, advertise and champion their ideas of new mobility concepts for future demands for a changing world and society, by a detailed presentation of the research and design process outcome, together with a convincing marketing concept.<br>In the final documentation the above mentioned is documented, illustrated and filed, comparing existing mobility concepts to the proposed concepts in terms of day-by-day usability, sustainability and expected costs, based on the proposed usage. |
| **Teaching Methods** | • lectures with problem based integrated exercises (ProfiL²)<br>• presentations from industry and academic partners<br>• project work in small teams, homework, practical seminar work<br>• practical work, excursions and presentations, milestone reviews |
| **Practical Laboratory Work** | - |
| **Language** | • Teaching: German<br>• Teaching material and some exercise: English |
| **Examination** | Active participation in seminary work, project work, project documentation, excursions and presentation of project outcome (individually and in teams) |
| **Prerequisites** | none |
| **Recommended Literature** | According to the selected subject |

**Workload**

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| *Teaching lessons:* | ***16 h*** | *16 h* | | |
| *Pre- and afterwork:* | ***16h*** | | *16 h* | *Project work:* |
| ***40 h*** | | *40 h* | | |
| *Preparation for examination:* | ***30 h*** | | | *30 h* |
| *Presentations/reports/papers:* | ***18 h*** | | *18 h* | |
| *In total:* | ***120 h*** | ***16 h*** | ***46 h*** | ***58 h*** |

| Technology Arts Sciences TH Köln | Technology of Material Flow & Robotics | TMR |
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| **Credits** | 4 |
| **Designated Degree** | Master of Science Automotive Engineering, 2. Semester |
| **Lecturer** | Prof. Dr.-Ing. Ralf Breede |
| **Responsible** | Prof. Dr.-Ing. Ralf Breede |
| **Content** | Technologies and systems for automated material flow within industrial production environments with an emphasis on automotive production processes.<br>The project results will be documented in a written report and presented by the students within the frame of the Scientific and Interdisciplinary Seminar (Team based Engineering Project). |
| **Learning Outcome** | The students are able to<br>• identify, choose or arrange suitable systems and their configurations,<br>• layout and programme typical robot applications,<br>• use a 3D-Simulation tool Delmia V5 Robotics. |
| **Teaching Methods** | • Introduction<br>• Project work |
| **Practical Laboratory Work** | Practical work focused on industrial 6-axis-robot applications and offline programming using Delmia V5 |
| **Language** | • Teaching: German<br>• Teaching material: English |
| **Examination** | Project results / documentation, project presentation, project discussion |
| **Prerequisites** | Knowledge of production processes and techniques, manufacturing principles and automation, project management, fundamentals of 3D-CAD/CAE-systems |
| **Recommended Literature** | Literature will be recommended relating to the subject of the project. |
| **Workload** | *Teaching lessons:* ***40 h***<br>*Pre- and afterwork:* ***60h***<br>*Preparation for examination:* ***20 h***<br>*In total:* ***120 h*** |

| Technology Arts Sciences TH Köln | Scientific Seminar / Advanced Technical English | ScSe / ATE |
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| **Credits** | No dedicated credits |
| **Designated Degree** | Master of Science Automotive Engineering, 1.& 2. Semester |
| **Lecturer** | Lecturers of faculty (technical supervison) & N.N. (supervision of English) |
| **Responsible** | Prof. Dr.-Ing. Michael Frantzen , Prof. Dr.-Ing. Peter Krug |

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| **Content** | In this modules students will work on a vehicle related subject with scientific back-ground provided by a lecturer of the faculty according to their choice.<br>To assist students in improving their skills in technical English, the work is addi-tionally supervised by native English speakers.<br>The project results will be docu-mented in a written report and presented by the stu-dents within the frame of the Scientific and Interdisciplinary Seminar (Scientific Engi-neering Project). |
| **Learning Outcome** | The students are able to<br>• analyse and evaluate English written scientific papers and theses with scientific-technical content,<br>• prepare sophisticated scientific reports in English language,<br>• prepare and to give presentations of scientific results in English language. |
| **Teaching Methods** | Guided independent study |
| **Practical Laboratory Work** | According to the selected subject |
| **Language** | • Teaching: English<br>• Teaching material: English |
| **Examination** | • Assessment of written report<br>• Assessment of presentation |
| **Prerequisites** | Fundamental knowledge according to the selected technical subject and fundamental knowledge in management methods |
| **Recommended Literature** | According to the selected subject |

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| **Workload** | *Guided independent study:* | ***h*** |
| | *Report preparation:* | ***h*** |
| | *Preparation of presentation:* | ***h*** |
| | *In total:* | ***h*** |

| Technology Arts Sciences TH Köln | Master Thesis | |
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| **Credits** | 30 |
| **Designated Degree** | Master of Science Automotive Engineering, 3. Semester |
| **Lecturer** | All lecturers of faculty |
| **Responsible** | Prof. Dr.-Ing. Michael Frantzen |

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| **Content** | The master thesis is an independently carried out engineering project from the area of the chosen profile within the MSc Automotive Engineering.<br>It includes a written documentation of the results as well as the scientific methods that were applied during the work.<br>It concludes with a verbal presentation and discussion of the project in the colloquium. |
| **Learning Outcome** | The students are able to<br>• apply the acquired theoretical knowledge,<br>• research and attain further theoretical knowledge that is necessary for the solution of the given problem,<br>• apply scientific methodology to the given task,<br>• use an interdisciplinary approach to a problem,<br>• plan and execute a longer-term project,<br>• work independently. |
| **Teaching Methods** | Independent work by the student, supervised by the lecturer |
| **Practical Laboratory Work** | - |
| **Language** | English or German written text (English is recommended) |
| **Examination** | • Written documentation of the work<br>• Oral examination in the colloquium |
| **Prerequisites** | Passed all six-credits-modules and one four-credit-module from the cluster “Scientific and Interdisciplinary Seminars” plus proven English skills. |
| **Recommended Literature** | Literature will be recommended relating to the according subject. |

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| **Workload** | *Thesis work:* | ***840 h*** |
| | *Colloquium preparation:* | ***90 h*** |
| | *In total:* | ***900 h*** |