HOCHSCHULE ESSLINGEN

MODULHANDBUCH

Design and Development in Automotive and Mechanical Engineering

(DDM)

Stand 24.09.2024

SPO Fassung vom 17. Mai 2022

Gültig ab September 2024

Änderungsverzeichnis

Datum	Beschreibung der Änderung	Bearbeiter
07/2024	4201: Inhaltliche Anpassung	SW
07/2024	4214: Anpassung Kontaktzeit, Prüfungsdauer, Dozenten	SW
07/2024	4204: Anpassung Dozenten	SW
07/2024	4205: Anpassung Dozenten	SW
07/2024	4209: Inhaltliche Anpassung, Dozenten	SW
09/2024	4207: Inhaltliche Anpassung	SW
09/2024	4213: Redaktionelle Änderung	SW

Hinweis zur Gültigkeit

Dieses Modulhandbuch gilt für Studierende, die das Studium nach der Version SPO Master–Betriebswirtschaft, Ingenieur- und Naturwissenschaften der Studien- und Prüfungsordnung der Hochschule Esslingen in der Fassung vom 17. Mai 2022 aufgenommen haben.

Sonstige Anmerkungen

Der Workload pro Creditpoint beträgt in diesem Studiengang (§8 (1) MRVO):

Credits	Workload in Stunden
1	30

Freigabe

Dieses Dokument ist zur Verwendung freigegeben, Esslingen, den 24.09.2024

gez. Prof. Dr.-Ing. Stefan Wagner

Fakultät Maschinen und Systeme
Studiengangkoordinator DDM

Kontaktpersonen Modulhandbuch

Studiengangkoordinator:

Name: Wagner, Stefan
Mailadresse: stefan.wagner@hs-esslingen.de
Fakultät: Maschinen und Systeme
Standort: Stadtmitte
Raum: S 09.109

Prüfungsausschussvorsitzende/r:

Name: Wagner, Stefan
Mailadresse: stefan.wagner@hs-esslingen.de
Fakultät: Maschinen und Systeme
Standort: Stadtmitte
Raum: S 09.109

Studienverlaufsplan / Modulübersicht / Struktur

Sem.	Module						Cr.
3	Master Thesis						30
2	Advanced Materials Technology	Design and Development 2	Design for Manufacturing	Vibration and Acoustics 2	Project Work		30
1	Numerical Methods in CAD	Design and Development 1	Adanced Strength of Materials	Vibration and Acoustics 1	Integrity of Structures	Dynamics	30

Grundlagen	Grundlagen fachspezifisch	Vertiefung fachspezifisch	Übergreifend (mit Softskills)

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Inhalt

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Module DDM 4201 – Numerical Methods in CAD

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	4201	DDM	1	☒WS ☐SS	1 Semester	Compulsory	120	4

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	English
	a) CAE Methods and Algorithms	Lecture	2	30	60	
	b) Numerical Mathematics	Lecture	2	30		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can …

Knowledge and Understanding

- Understand the basics of mathematical concepts within the framework of the topics in section 4
- Have advanced knowledge of engineering mathematics and numerical methods in particular
- Understand the relevance of mathematics for mechanical engineering

Use, Application and Generation of Knowledge

- Apply mathematical concepts within the framework of the topics in section 4
- Decide whether a solution is plausible or not
- Analyse advanced problems of mechanical engineering and work out mathematical solutions

Communication and Cooperation

- Make use of the knowledge, abilities and competences in order to evaluate a given application problem
- Communicate within a team to work out a solution to a given problem

Scientific Self-Conception/ Professionalism

- Justify a solution methodically
- Assess their abilities in comparison to their fellow students

4 **Contents**

- Advanced topics of matrix calculus
- Analysis of functions of several variables (especially optimisation)
- Iterative methods for solving linear equation systems
- Power series, Taylor series, Fourier series
- Numerical methods for initial value problems of ordinary differential equations

5 **Participation Requirements**

Compulsory: Mathematics from the bachelor studies

6 **Examination Forms and Prerequisites for Awarding ECTS Points**

Written examination (90 minutes); graded

7 **Further Use of Module**

Compulsory module for DMM studies

8 **Module Manager and Full-Time Lecturer**

Prof. Dr. rer. nat. Axel Stahl

9	**Literature** • Lecture notes (provided for download) • Koch-Stämpfle, Mathematik für das Ingenieurstudium, Hanser Verlag • Mohr, Numerische Methoden in der Technik, Grenzwert Verlag • Weller, Numerische Mathematik für Ingenieure, Vieweg Verlag • O'Neil, Advanced Engineering Mathematics, Cengage Learning • Kreyszig, Advanced Engineering Mathematics, Wiley
10	**Last Updated** 01.07.2024

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Module DDM 4214 – Design and Development 1

1	Module Number	Study Programme	Semester	Offered in	Duration	Module Type	Workload (h)	ECTS Points
	4214	DDM	1	☒WS ☐SS	1 Semester	compulsory	180	6

2	Courses	Teaching and Learning Forms	Contact Time (SWS)	Contact Time (h)	Self-Study Time (h)	Language
	a) Design Methodology Case Study	Lecture	2	30	110	English
	b) Ecologic and Economic Design	Lecture	2	30		
	c) Reliability	Lecture	2	30		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Understand and explain the concepts and principles of ecologic and economic design.
- Describe the product development process.
- Understand the basics of reliability engineering.

Use, Application and Generation of Knowledge

Use and Transfer

- Apply the concepts and principles of ecologic and economic design in their own projects and processes.
- Take different perspectives and points of view on a given situation, weigh them up against each other and choose the best design or process with respect to ecologic and economic aspects.
- Use the methods and concepts of reliability engineering.
- Calculate reliability characteristics.
- Familiarize themselves with new ideas and topics based on their basic knowledge in reliability.

Scientific Innovation

- Improve the design of engineering concepts and processes in order to improve their ecologic and economic aspects and their reliability.

Communication and Cooperation

- Communicate actively within an organization and obtain information about ecologic and economic design Aspects.
- Communicate and cooperate within the group in order to find adequate solutions for ecologic and economic design aspects and their reliability (e.g. FMEA).
- Interpret the results of the reliability assessments and draw admissible conclusions.
- Use the learned knowledge, skills and competences to evaluate the reliability and interpret the results according to other aspects.
- Present reliability contents and discuss them.

Scientific Self-Conception/ Professionalism

- Derive recommendations for decisions from a ecologic and economic perspective on the basis of the analyses and evaluations made.
- Justify the results of reliability analysis theoretically and methodically.

4 **Contents**

a) Design Methodology Case Study: Design constraints, QCD requirements, design and development Team, breakdown structures, functional decomposition of technical systems, product design specification, V – Cycle, tender and project cost management, change and configuration Management, safety management and engineering

b) Ecologic and Economic Design: Resources, future resource availability, negative effects of industrial processes and products on humans and the environment, environmental burden of disease in Europe, EU directives on environmental protection (design engineering view), ECO-design methods including Luttrop's "Golden Rules and additions", ecological design and economic design - no area of conflict!

c) Reliability: Definition, significance and overview of reliability, techniques in the product development and in the product life cycle; statistics, probability theory, life time distribution, reliability of systems; FMEA, Boolean system theory; proof of reliability, planning of tests, collecting field data; reliability software;

5	**Participation Requirements** Compulsory: Fundamentals of strength of materials, engineering mechanics and material science. Mathematics: Basic knowledge of statistics. Fundamentals of automotive engineering Recommended: design technology, engineering mathematics
6	**Examination Forms and Prerequisites for Awarding ECTS Points** a) Design Methodology Case Study: Certificate a) and b) Design Methodology Case Study and Ecologic and Economic Design: Written exam 90 minutes (closed) c) Reliability: Written exam 60 minutes (open)
7	**Further use of Module** Design and Development 2 incl. Design of Experiments
8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Andrea Buck Lecturer: Prof. Dr.-Ing. Benjamin Klein, Prof. Dr.-Ing. Andrea Buck, Prof. Dr.-Ing. Tobias Leopold
9	**Literature** Eberhard Abele, Reiner Anderl, Herbert Birkhofer, Bruno Rüttinger: EcoDesign - Von der Theorie in die Praxis; Springer Berlin Heidelberg, 2008 Alessandro Freddi, Mario Salmon: Design Principles and Methodologies - From Conceptualization to First Prototyping with Examples and Case Studies; Springer International Publishing AG, part of Springer Nature 2019 Bertsche, Bernd: Reliability in Automotive and Mechanical Engineering, Springer, Berlin, 2008
10	**Last Updated** 01.07.2024

Module DDM 4203 – Advanced Strength of Materials

1	**Module Number** 4203	**Study Programme** DDM	**Semester** 1	**Offered in** ☒WS ☐ SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 180	**ECTS Points** 6
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	English
	a) Lightweight Design		Lecture		4	60	90	
	b) Advanced Finite Element Method		Lecture with Laboratory		2	30		
3	**Learning Outcomes and Competences** Once the module has been successfully completed, the students can … **Knowledge and Understanding** • Understand the sequence of a linear finite element analysis. • Understand in depth the concept of nodes, integration points and interpolation functions. • Understand the influence of various factors on the lightweight potential of a structure. **Use, Application and Generation of Knowledge** *Use and Transfer* • Apply the finite element method to analyse the deformation and stress/strain state of a structure. • Apply lightweight design concepts in relation to materials and shapes. • Analyse the failure behaviour of technical sandwich structures. *Scientific Innovation* • Optimize sandwich structures for minimum weight under different side conditions. • Improve the weight-to-load ratio of structures. **Communication and Cooperation** • Interpret the results of a numerical simulation and a lightweight optimization and draw admissible conclusions. • Present technical contents and discuss them. • Communicate and cooperate within the group in order to find adequate solutions for the task at hand. **Scientific Self-Conception/ Professionalism** • Justify solutions theoretically and methodically. • Reflect and assess the abilities of group members.								
4	**Contents** a) Lightweight Design: Principles and objectives of lightweight design; One-dimensional members (Bars and Beams); Plates and shells; Stability problems; Selected examples of lightweight design b) Advanced Finite Element Method: Theoretical background of FEM, fundamental equations, numerical accuracy and convergence, applications and influence of boundary conditions, nonlinearity (material); lab exercises							
5	**Participation Requirements** Compulsory: Fundamentals of strength of materials, materials science, engineering mechanics, design and finite element method Recommended: NA							
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Advanced Strength of Materials: Written exam, 120 minutes, graded Advanced Finite Element Method: Individual semester project, not graded							
7	**Further use of Module** NA							

8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Andreas Öchsner Lecturer: Prof. Dr.-Ing. Andreas Öchsner, D.Sc.
9	**Literature** Lecture Documents; textbook references will be given in the lecture
10	**Last Updated** 18.04.2021

Module DDM 4204 - Vibration and Acoustics 1

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	4204	DDM	1	☒WS ☐SS	1 Semester	compulsory	120	4

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	English
	a) Vibration and Acoustics Measurement	Lecture	2	30	75	
	b) Vibration and Acoustics Measurement	Laboratory	2	15		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Explain the basic procedure of vibrations and acoustic measurement techniques and understand the connections within theoretical basics and practical measurement.
- Describe basics of mechanical vibrations, optical, holographic and other vibrational measurement techniques.
- Basic knowledge in the mathematical, mechanical and optical fundamentals of vibrational measurement techniques.
- Recognize the significance of the subject to development process of mechanical and automotive systems.
- Understand and explain single degree of freedom (SDOF) vibrational models, digital signal processing (DSP) and fourier transform process (DFT and FFT), basics of laser light and holography.

Use, Application and Generation of Knowledge

Use and Transfer

- Apply principles of optical laws, DSP, DFT and FFT to Frequency Response Function (FRF) and Order Tracking measurements.
- Create lab reports and presentations.
- Analyse vibrational and acoustic behaviour of chosen automotive components.
- Recognize and classify connections.
- Analyse vibrational and acoustic problems and derive or develop solutions.
- Take different perspectives and points of view on a given situation, weigh them up against each other and make an assessment.
- Design components with wanted vibrational and/or acoustic properties.
- Calculate basic properties of SDOF models.
- Familiarize themselves with new ideas and topics based on their basic knowledge.

Scientific Innovation

- Develop concepts for the vibrational and acoustic optimization of mechanical and automotive components.

Communication and Cooperation

- Interpret the results of vibrational and acoustic measurements and draw admissible conclusions.
- Present FRF and operational deflection shapes and discuss them.
- Communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- Justify the solution theoretically and methodically.
- Reflect and assess one's own abilities in a group comparison.

4 **Contents**

a) Vibration and Acoustics Measurement: Vibration measurement by mechanical means, optical and laser basics, vibration measurement by interferometric and holographic means, acoustic noise measurement, analysis of dynamic signals.

b) Laboratory Vibration and Acoustics Measurement: Introduction and handling of measurement equipment, basics of interferometry, FRF measurement on an automotive component, order tracking measurement on a car, electronic speckle interferometry (ESPI), laser vibrometry.

5	**Participation Requirements** Compulsory: Basic knowledge on fundamentals of optics and vibrations (Bachelor degree level) Recommended: NA
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written exam, 90 minutes, graded Lab reports and tests, not graded
7	**Further use of Module** 4210 Vibrations and Acoustics 2
8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Joachim Berkemer Lecturer: Prof. Dr.-Ing. Joachim Berkemer, Prof. Dr. rer. nat. Hanno Käß, Dr. Pradeep Narrain
9	**Literature** Lecture documents, Ewins, D.J.: Modal Testing. Theory and Practice. New York: John Wiley and Sons. Eugene Hecht: Optics, Pearson New Internat. Edition, Pedrotti: Introduction to Optics Pearson
10	**Last Updated** 04.07.2024

Module DDM 4205 - Integrity of Structures

1	**Module Number**	**Study Program**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	4205	DDM	1	☒WS ☐SS	1 Semester	compulsory	180	6

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	English
	a) Integrity of Structures	Lecture with Laboratory	4	40	110	
	b) Failure Analysis:	Lecture with Laboratory	2	30		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Understand the advanced concepts to evaluate the operational safety and integrity of engineering/car structures under static and cyclic loading
- Understand and explain the procedure for a life-time-assessment of components under variable amplitude loading.
- Basic knowledge about fatigue behaviour under complex multiaxial loading
- Understand principles and methodology of failure investigation
- Explain typical failure patterns and failure modes of engineering structures
- Understand reasons, characteristics and types of failures.

Use, Application and Generation of Knowledge

Use and Transfer

- Apply advanced concepts for an experimental and theoretical life-time-assessment for cyclically loaded components to real-life-problems
- Apply fracture mechanics to cracked structures under quasistatic and cyclic loading
- Calculate the life time until fatigue failure by hand for simple applications and load-time-histories
- Calculate the life time until fatigue failure using commercial software programs
- Analyse failed specimen in terms of failure cause and give technical solutions for remedies
- Create solutions how to prevent failures

Scientific Innovation

- Improve the design of safety relevant engineering structures in order to guarantee their safety and reliability under service conditions and the potential for lightweight design

Communication and Cooperation

- Interpret the results of the component safety and lifetime and draw admissible conclusions.
- Use the learned knowledge, skills and competences to evaluate the safety and integrity of engineering components and structures.
- Communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- Derive recommendations for decisions concerning the safety of components under service loading and their release on the basis of the analyses and evaluations learnt.

4	**Contents** a) Integrity of Structures: Advanced concepts for the life-time assessment under variable amplitude loading: Nominal stress concept for cyclic loading, structural stress concept for cyclic loading, local stress concept for cyclic loading, local strain concept for cyclic loading, fracture mechanics concept Application of numerical tools for the life time prediction Selected topics / ongoing research topics: e.g. very high cycle fatigue (VHCF); fatigue behaviour of composite materials; Influence of edge conditions on fatigue behaviour, multiaxial fatigue… Laboratory exercises: Non-destructive testing, experimental determination of material and component flow curve, Neuber`s Law, Masing behaviour, local stress-strain loops, test drives with strain gauges, collecting data for load time history, numerical life time assessment b) Failure Analysis: Historical failures, typical failures at car structures, reason for failures, concepts for component optimization, definition and classification of failures, methods of failure analysis, characteristics of failures under static and cyclic mechanical, thermal and chemical loading, practical case studies and exercises
5	**Participation Requirements** Compulsory: Fundamentals of strength of materials; fundamentals of fatigue of materials, fundamentals of engineering mechanics and material science, basic knowledge of statistics Recommended: Module Strength of Materials 1, Module Strength of Materials 2 or Precourse Strength of Materials / Integrity of Structures
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written exam, 120 minutes, graded Lab reports and lab tests
7	**Further use of Module** NA
8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Peter Häfele Lecturer: Dr.-Ing. Felix Dittmann, Dr.-Ing. Martin Schlegl
9	**Literature** Lecture Documents Hertzberg, R. W.: Deformation and Fracture Mechanics of Engineering Materials, 6th edition, John Wiley and Sons, 2020 Dowling, N. E.: Mechanical Behavior of Materials.4th edition, Pearson, 2013 Lee, Y., Barkey, M. E., Kang, H.: Metal Fatigue Analysis Handbook: Practical Problem-solving Techniques for Computer-aided Engineering, 1st edition, Butterworth-Heinemann, 2011 Bannantine, J. A., Comer, J. J., Handrock, J. L.: Fundamentals of Metal Fatigue Analysis, Prentice Hall, 1997 Collins, J. A., Failure of Materials in Mechanical Design. Analysis, Prediction, Prevention. 2nd edition, John Wiley & Sons, 1993 FKM Guideline: Analytical Strength Assessment of Components: 6th Edition, Forschungskuratorium Maschinenbau FKM, 2012 FKM Guideline: Fracture Mechanics Proof of Strength for Engineering Components, 3rd Edition , FKM, 2009 Brett, Mc L.: Handbook of Failure Analysis of Materials in Mechanical Design: Identification, Prediction and Prevention, Auris, 1st edition, 2013 ASM-Handbook. American Society for Metals. Metals Park Ohio Vol. 9: Metallography and Microstructure. Vol. 10: Failure Analysis and Prevention Vol. 12: Fractography Vol. 19: Fatigue and Fracture Wulpi, D.J.: Understanding How Components Fail. American Society for Metals. Metals Park, 3rd edition, 2013
10	**Last Updated** 01.07.2024

Module DDM 4206 - Dynamics

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	4206	DDM	1	☒WS ☐SS	1 Semester	compulsory	120	4

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	English
	a) Multi Body Systems	Lecture	2	30	60	
	b) Simulation of Multi Body Systems	Virtual Lab	2	30		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Explain the basic assumptions of simulating machine parts as rigid bodies.
- Explain the difference between rigid and flexible bodies.
- Model robots, automotive suspensions etc. as multi body systems (mbs).
- Describe the connections between rigid bodies by joints or force elements.
- Understand the fundamentals of rigid body dynamics.
- Understand the principles of the related software.

Use, Application and Generation of Knowledge

Use and Transfer

- Extract mbs input parameters from CAD models.
- Simulate motion and forces of mechanism.
- Create user defined force elements or joints.
- Analyse the results of multi body simulations.
- Visualise simulation results with computer animation.
- Familiarize themselves with new ideas and topics based on their basic knowledge.

Scientific Innovation

- Use methods and tools to gain new insights in the field of multi body simulation.
- Create new mathematical models for constraints between bodies.
- Optimize system topology and system parameters.
- Verify simulation results with experiments.
- Independently develop new algorithms for real time simulation of multi body systems.
- Develop concepts for integrating multi body systems into multi domain simulations.

Communication and Cooperation

- Work together with IT experts in simulation software development.
- Interpret the results of simulations and draw admissible conclusions.
- Communicate and cooperate with mechanical designers and testing engineers.

Scientific Self-Conception/ Professionalism

- Justify the solution theoretically and methodically.
- Reflect and assess one's own abilities in scientific research in that field.

4 **Contents**

a) Multi Body Systems:
Description of finite rotations, rotation matrix, speed and acceleration, forces and constraints, equations of motion, state-space equations, numerical solutions, user defined force elements.

b) Simulation of Multi Body Systems:
Introduction to Matlab Symbolic toolbox and Simcape. Modelling and Simulation of different examples with SimMechanics, e.g.: mechanical conveyor, hydraulic excavator,
Modelling and calibration of subsystems of “Esslingen Driving Simulator” and system integration in group work.

5	**Participation Requirements** Compulsory: Fundamentals of engineering mechanics: coordinate systems kinematics, forces and torques, Newton's law of motion; Mathematics: Basic knowledge of ordinary differential equations Recommended: Mathematical Methods in Engineering.
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Multi Body Systems: Written exam, 90 minutes, graded Simulation of Multi Body Systems: Group projects with presentations, not graded
7	**Further use of Module** Modules 4208 Design and Development 2, 4210 Vibrations and Acoustics 2
8	**Module Manager and Full-Time Lecturer** Prof. Dipl.-Ing. Mathias Oberhauser
9	**Literature** Lecture documents, Power point presentations, Tutorials for SimScape and SimMechanics Wittenburg, J.: Dynamics of Systems of Rigid Bodies, Teubner, Stuttgart, 1977. Schiehlen, O. W.: Multibody Systems Handbook, Springer Verlag, 1990.
10	**Last Updated** 29.04.2019

Module DDM 4207 - Advanced Materials Technology

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	4207	DDM	2	☐WS ☒SS	1 Semester	compulsory	180	6

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	English
	a) Advanced Engineering Materials	Lecture	2	30	90	
	b) Surface Technology	Lecture	2	30		
	c) Composite Materials	Lecture	2	30		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Understand the structure, mechanical and surface properties of modern metallic and composite materials and understand the connections within the material technology.
- Describe the strengthening mechanism of advanced metallic and composite materials
- Recognize the significance of advanced materials technology.

Use, Application and Generation of Knowledge

Use and Transfer

- Take different perspectives and points of view on a given situation, weigh them up against each other and select suitable materials.
- Design components by using the knowledge of modern advanced materials and basic material science.
- Select suitable materials considering the mechanical and surface properties, also considering the interactions between different materials in mixed construction.

Scientific Innovation

- Independently develop approaches for new concepts and assess their suitability.
- Develop concepts for the optimization of technical applications.

Communication and Cooperation

- Interpret the results of evaluation and optimisation processes and draw admissible conclusions for material selection.
- Use the learned knowledge, skills and competences to evaluate material selection and interpret them considering the boundary conditions.
- Communicate and cooperate within a team in order to find adequate solutions for the optimal metallic and composite materials.

Scientific Self-Conception/ Professionalism

- Derive recommendations for decisions regarding material selection on the basis of the analyses and evaluations made.
- Justify the material selection theoretically and methodically.
-

4 Contents

a) Advanced Engineering Materials:
Car Body Technology: Car Body Parts, Deep Drawing, Cutting, Hemming, Extruding, Integrated Approach
Sheet Materials: Strengthening, Production of Sheet Materials, Properties
High Strength Steel Sheets: Phases, Mild Steels, BH-Steels, Micro Alloyed Steels, Multiphase Steels, Press Hardening Steels, Recent Developments, Green Steel
Aluminium Sheets: Wrought Alloys, Strengthening Mechanism, Naturally Hard Alloys (5xxx), Precipitation Hardenable Alloys (6xxx), Superplasticity, Aluminium/Steel-Mix Bodywork
Tailored Components: Tailored Blanks, Partial Press Hardening, Multilayer Sheets, Fusion Sheets
Plastic Behaviour: Characteristic Values, Anisotropy, Yield Locus, Plastic Behaviour, Forming Limits

b) Surface Technology: Basics in corrosion, thermal coating, CVD, PVD, electrochemical deposition, corrosion protection of stainless steel and light metals, leak, sealing, dip coating, design of the corrosion protection for all the components of passenger cars, testing methods

c) Composites materials: Understanding the concept of fiber-reinforced composites. Prediction of elastic properties of laminae. Understanding the macromechanics of a lamina. Understanding the macromechanics of a laminate. Solution of design problems.

5	**Participation Requirements** Compulsory: Basic knowledge in the nature, behaviour and processing of construction materials and in material science: metals and alloys, especially steels and polymers Recommended: NA
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written exam, 120 minutes, graded
7	**Further use of Module** NA
8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Stefan Wagner Lecturer: Prof. Dr.-Ing. Stefan Wagner, Prof. Dr.-Ing. Andreas Öchsner Dr.-Ing. Regis Lallement
9	**Literature** Lecture documents, assignment documents, Power point presentations Ashby, Michael F., Jones, David R. H.: Engineering Materials 1 and Engineering Materials 2 Askeland, Donald R.:, The Science and Engineering of Materials Ashby, Michael F. : Materials Selection in Mechanical Design Öchsner, A.: Micromechanics of Fiber-Reinforced Laminae, Springer 2022 Öchsner, A.: Foundations of Classical Laminate Theory, Springer 2021
10	**Last Updated** 17.09.2024

Module DDM 4208 - Design and Development 2

1	Module Number	Study Programme	Semester	Offered in	Duration	Module Type	Workload (h)	ECTS Points
	4208	DDM	2	☐WS ☒SS	1 Semester	compulsory	120	4

2	Courses	Teaching and Learning Forms	Contact Time (SWS)	Contact Time (h)	Self-Study Time (h)	Language
	a) Advanced CAD	Lecture	2	30	60	English
	b) Design of Experiments	Lecture	2	30		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can …

Knowledge and Understanding

- Get a deeper practical and theoretical insight into the various modules of a CAD system.
- Possibilities of a parametric system, such as programming and automated modelling.
- Extensive knowledge of data exchange
- Extensive knowledge to generate surface models.
- Explain the basic procedure of the DOE and understand the connections within the DOE.
- Describe and use different applications of DOE-methods.
- Transfer the knowledge from theory of DOE to practical tests.
- Understand and explain the importance of planning effective tests.

Use, Application and Generation of Knowledge

Use and Transfer

- Knowledge and practice in handling a parametric and history / non-based CAD systems
- Knowledge and practice of automated feature generation and programming
- Knowledge and application of various simulation tools
- Knowledge in the specifics by creation of surface models
- Knowledge about capabilities of modern CAD systems
- Create designs based on given requirements and boundary conditions.
- Understand the basics of the application of DOE methods.
- Analyse performed tests and derive mathematical models to develop solutions.
- Reflect findings from the experiments into the design.

Scientific Innovation

- Programme model generation by creation of family tables.
- Structure and engineering approach to creating CAD models and assemblies
- Set up hypothesis tests.
- Create statistical tests, derive new models and optimize design or simulation tasks.
- Use methods and tools to gain new insights in the area of optimization and reliability of virtual simulation models or real product behaviours.

Communication and Cooperation

- Interpret results of simulations based on special leads.
- Use learned knowledge, skills and competences to model complex geometry well-structured and with high quality requirements
- Interpret the results of the evaluated DOE, make suggestions for optimization due to reliability and draw admissible conclusions.
- Use the learned knowledge, skills and competences to evaluate the DOE and interpret them according to other aspects.
- Present the derived models and discuss them within the development team.

Scientific Self-Conception/ Professionalism

- Select CAD systems based on learned criteria
- Decide how to model complex geometry economically and with high quality requirements
- Select and use data exchange formats
- Derive recommendations for decisions from a technical perspective on the basis of the analyses and evaluations made.
- Justify the solution theoretically and methodically.

4	**Contents** a) Advanced CAD: General introduction in the latest Revision CREO from PTC with practices; Learning of special advanced features of a CAD system; Learning of special advanced modules of a CAD system, like sheet metal, surface, mechanism, cabling and piping. Several programing tools and possibilities; Criteria for choosing a CAD System; Subassembly and skeleton technology; CAD and Internet; Data exchange, direct and indirect data exchange; Many practice by using the CAD-System by working out examples; Theoretical background of CAD-System modules. b) Design of Experiments: General introduction into DOE, differences to experience-based test planning, execution and results of a DOE; Attempts plan: selection parameters to be investigated and result sizes, establishing the testing area; Test plan designs: Overview DOE designs (factorial, response surface, mixture, optimal designs), selection of designs; Creating designs with a DOE software tool; Specific variables in the DOE: randomization, blocks replication, resolution / confounding; Evaluation of experimental design results: effects and effect size, interactions, statistical tests in the DOE, review the validity; Optimization calculation, prediction and confirmation tests: graphical representation of the effects of parameters, numerical optimization, predict outcomes, evaluation of test results; Application of the DOE to some practical examples as well to a final exercise with all the main points mentioned
5	**Participation Requirements** Compulsory: Bachelor Degree in Automotive or Mechanical Engineering Recommended: Basic knowledge and education in CAD system
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Advanced CAD: Several attestations, graded Design of Experiments: Written exam 60 min, graded
7	**Further use of Module** NA
8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Steffen Greuling Lecturer: Dipl.-Ing. (FH) Ulrike Schwanke, Prof. Dr.-Ing. Steffen Greuling
9	**Literature** Lecture Documents; Power point presentations [1] D.C. Montgomery, Design and Analysis of Experiments, 10th Edition, Wiley, 2019. [2] M.J. Anderson, P.J. Whitcomb, DOE Simplified: Practical Tools for Effective Experimentation, 3rd Edition, CRC Press, 2016. [3] R.H. Myers, D.C. Montgomery, C.M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization Using Designed Experiments, 4th Edition, Wiley, 2016. [4] T.T. Allen, Introduction to Engineering Statistics and Lean Six Sigma – Statistical Quality Control and Design of Experiments and Systems, 3rd Edition, Springer, 2019.
10	**Last Updated** 01.08.2023

Module DDM 4209 - Design for Manufacturing

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	4209	DDM	2	☐WS ☒SS	1 Semester	compulsory	240	8

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	English
	a) Production-oriented Product Design	Lecture	6	90	120	
	b) Product Life Cycle Management	Lecture plus Virtual Laboratory	2	30		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Explain the basic procedure of the design for manufacturing and understand the connections within the design for manufacturing.
- Describe technical basics of the manufacturing processes
- Basic knowledge in the design for manufacturing.
- Recognize the significance of the design for manufacturing.
- Understand welding of materials, root cause investigations and polymer manufacturing processes.
- Understand and explain welding of materials, root cause investigations and polymer manufacturing processes.

Use, Application and Generation of Knowledge

Use and Transfer

- Apply technical laws.
- Create technical reports and presentations.
- Analyse technical solutions.
- Recognize and classify connections.
- Understand the basics of the subject.
- Analyse technical problems and derive or develop solutions.
- Take different perspectives and points of view on a given situation, weigh them up against each other and make an assessment.
- Design of products.
- Calculate simulate models to optimise manufacturing processes and parts.
- Familiarize themselves with new ideas and topics based on their basic knowledge.

Scientific Innovation

- Use methods and tools to gain new insights in the field of manufacturing.
- Create new models to develop new manufacturing processes and parts.
- Optimize systems.
- Set up hypothesis tests.
- Independently develop approaches for new concepts and assess their suitability.
- Develop concepts for the optimization of technical applications.
- Improve applications in respect of the manufacturing process.

Communication and Cooperation

- Communicate actively within an organization and obtain information.
- Interpret the results of the field and draw admissible conclusions.
- Use the learned knowledge, skills and competences to evaluate the manufacturing processes and interpret them according to other aspects.
- Present technical contents regarding to manufacturing processes and discuss them.
- Communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- Derive recommendations for decisions from a social and ethical perspective on the basis of the analyses and evaluations made.
- Justify the solution theoretically and methodically.
- Reflect and assess one's own abilities in a group comparison.

4	**Contents** a) Production-oriented Product Design: Part 1: Root cause investigation: root cause investigation on failing products with the aim to identify failures in production oriented product design, 4 to 6 cases, ambivalent data situation, insufficient information, without obviously correct answers and a ticking clock, which requires fast actions, inter-cultural investigation teams. Part 2: Basics (process, weldability of materials and design) for relevant joining technologies (e.g. laser beam welding, resistance welding, friction welding, ultrasonic welding, mechanical joining, adhesive bonding), methods of quality assurance in production, health and safety instruction, industrial applications, practical laboratory Part 3: Textile techniques, composite design, production of preforms, thermoplastic and thermoset processes, organic sheet moulding, taping, resin transfer moulding, reactive injection moulding, polymer press processes, repairing of composite materials, joining of polymer materials b) Product Life Cycle Management: Understanding sustainability aspects, the method LCA (Life Cycle Assessment) and trends in industry and society with respect to sustainability, training and application with LCA software UMBERTO (executing LCA in groups)
5	**Participation Requirements** Compulsory: Bachelor Degree in Automotive or Mechanical Engineering Recommended: NA
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written exam, 120 minutes, graded Product Life Cycle Management: Individual semester project
7	**Further use of Module** -
8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Matthias Deckert Lecturer: Prof. Dr.-Ing. Matthias Deckert, Prof. Dr.-Ing. Andrea Buck, Dr.-Ing. Régis Lallement, Prof. Dr.-Ing. Sandra Hartl
9	**Literature** Lecture documents, ISO 14040/14044, LCAs
10	**Last Updated** 01.07.2024

Module DDM 4210 - Vibration and Acoustics 2

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	4210	DDM	2	☐WS ☒SS	1 Semester	compulsory	120	4

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	English
	a) Vibrations	Lecture	2	30	60	
	b) NVH in Automotive Systems	Lecture	1	15		
	c) Computer-Aided Vibration Analysis	Virtual Lab	1	15		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Explain the basic procedure of the setup of multiple degree of freedom (MDOF) models and understand the connections to NVH behaviour of automotive systems.
- Understand and explain the calculation of MDOF modal properties and mode shapes and the modal superposition method on example of MDOF Frequency Response Functions; fundamentals of plain wave and spherical wave models in acoustics with special focus to sound intensity.

Use, Application and Generation of Knowledge

Use and Transfer

- Apply matrix calculation methods to calculate modal properties and mode shapes; apply experimental modal analysis methods; apply CAE and CAT methods on MDOF systems.
- Analyse MDOF models by computational and experimental methods; analyse sound intensity of a sound field
- Calculate MDOF models with Matlab and Finite Elements.

Scientific Innovation

- Develop concepts for the optimization of NVH behaviour of automotive components by computational and experimental modal methods.

Communication and Cooperation

- Interpret the results of modal analyses and draw admissible conclusions.
- Present results of modal analyses and discuss them.
- Communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- Justify the solution theoretically and methodically.
- Reflect and assess one's own abilities in a group comparison.

4 **Contents**

c) Vibrations: Introduction to the basic theory of vibrations; practical application to typical structural noise and shake problems; principles of Fourier analysis and order tracking; multiple degree of freedom systems.
d) NVH In Automotive Systems: Definition of NVH; acoustic and vibration problems in vehicle systems.
e) Computer-Aided Vibration Analysis: Simulation of practical vibration problems (CAT).

5 **Participation Requirements**

Compulsory: Basic knowledge in dynamics. Mathematics: Linear differential equations. 4204 Vibrations and Acoustics 1.

Recommended: Vibrations and Acoustics 1 exam passed

6 **Examination Forms and Prerequisites for Awarding ECTS Points**

Written exam, 90 minutes, graded

Laboratory reports and tests, not graded

7	**Further use of Module** NA
8	**Module Manager and Full-Time Lecturer** Prof. Dr.-Ing. Joachim Berkemer
9	**Literature** Lecture Documents; Ewins, D.J.: Modal Testing. Theory and Practice. New York: John Wiley and Sons. Argyris, J.; Mlejnek, H.-P.: Computerdynamik der Tragwerke. Braunschweig, Wiesbaden: Friedr. Vieweg Verlag Further textbook references will be given in the lecture
10	**Last Updated** 02.04.2019

Module DDM 4213 – Project Work

1	**Module Number** 4213	**Study Programme** DDM	**Semester** 2	**Offered in** ☐WS ☒SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 240	**ECTS Points** 8
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
	Project Work		Project Work		**(SWS)** 8	**(h)** 160	**(h)** 80	Englisch

3 **Learning Outcomes and Competences**

The project is carried out in a group consisting of 3 or 4 students each. Deviations from the planned group size require the approval of the study coordinator DDM.

The information, data and documents required for the processing of the respective tasks are obtained by the project groups themselves within the framework of the project processing.

Each week, the students present the results achieved so far to the project groups in a meeting with the project supervisor. Project management and task-related coaching is provided by the respective project supervisor as part of this meeting.

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Develop a project plan
- Split complex tasks into subtasks.
- Apply the knowledge from lectures and labs on a real application.
- Understand the limitations of project time and human resources.

Use, Application and Generation of Knowledge

Use and Transfer

- Use methods and tools of project management.
- Understand the principles of systems engineering.
- Work with state of the art engineering software and measurement equipment.

Scientific Innovation

- Describe interfaces of complex systems.
- Apply scientific methods to solve industrial problems.
- Discuss pros and cons of new solutions in a group.
- Interpret measurement data and simulation results.

Communication and Cooperation

- Work together according to a project plan
- Take into account cultural differences in working style, leadership and communication.
- Cooperate within the group in order to find adequate solutions for the project task.

Scientific Self-Conception/ Professionalism

- Work successfully in international development groups in industry.

4 **Contents**

Independent work on a given individual engineering task in a project team consisting of several students (usually 3 to 4 students) under the guidance and support of project supervisors.

Writing of a scientific project report.

Weekly discussion/coaching of the project progress with the project supervisor.

Within the framework of the seminar: Presentation of project results.

5 **Participation Requirements**

compulsory: Lectures and labs of first semester (DDM1)

recommended: Basic knowledge of project management , basic knowledge of team work

6	**Examination Forms and Prerequisites for Awarding ECTS Points** a) Group report b) Presentation in a group (20 minutes) + discussion (10 minutes)
7	**Further Use of Module** Preparation for Master Thesis
8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Stefan Wagner Lecturer: Supervision of a professor of the Faculties Mechanical and Systems Engineering or Mobility and Technology acc. to topic
9	**Literature** Art of Project Management; by Scott Berkun; ISBN: 0596007868 Project Management For Dummies; by Stanley E. Portny; ISBN: 0470049235
10	**Last Updated** 17.09.2024

DDM Module 4212 – Master Thesis

1	**Module Number** 4212	**Study Programme** DDM	**Semester** 3	**Offered in** ☒WS ☐SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 900	**ECTS Points** 30
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	
	a) Soft Skills		Lecture, group work		3	45	145	Englisch
	b) Master Thesis		Thesis		24	700		
	c) Defence		Presentation		3	10		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- Handle and solve a problem with scientific methods on their own.
- Professionally communicate with others.
- Analyse of communication and behaviour patterns and adequate reactions
- Manage specific situations and projects

Use, Application and Generation of Knowledge

Use and Transfer

- Do scientific literature research.
- Write a scientific report.
- Give a presentation about thesis results.
- Organize themselves.

Scientific Innovation

- Understand the theories and their limitations in there engineering discipline.
- Find new solutions.

Communication and Cooperation

- Give comprehensive intermediate reports to supervisors.
- Work together with technical staff in industrial labs.
- Cooperate within their own department and other departments and suppliers.

Scientific Self-Conception/ Professionalism

- Work in R&D departments in industry
- Join a PhD program

4 Contents

a) Soft Skills:
Communication: Sender/receiver model, levels of communication, perception and interpretation, NLP
Presentation: Generation of presentations, advanced presentation techniques
Teambuilding: Individual types according to MBTI, Team Set-Up
Management and Leadership: Aims, Missions, Visions, Values, Corporate Governance, Motivation, Leadership Competence

b) Master Thesis: Constitution of project structure (time schedule, work packages), realisation of given task with scientific methods and within a given timeframe, documentation and evaluation of results

c) Defence: Presentation and defence of results

5 **Participation Requirements**

compulsory: Lectures and labs of first and second semester, team project

recommended: -

6	**Examination Forms and Prerequisites for Awarding ECTS Points** a) Group work with test, oral presentation 30 minutes b) Thesis report c) Presentation and oral examination , 30 minutes
7	**Further Use of Module** NA
8	**Module Manager and Full-Time Lecturer** Responsible: Prof. Dr.-Ing. Stefan Wagner Lecturer: Supervision of a professor of the Faculties Mechanical and Systems Engineering or Mobility and Technology acc. to topic
9	**Literature** NA
10	**Last Updated** 18.04.2021