Automotive Engineering
Module Handbook

- Courses in English* -

- Introduction to body in white design
- Introduction to commercial vehicle design
- Introduction to vehicle dynamics
- Drive train design
- Finite Element Methods (FEM)
- Vibration theory & acoustics
- Engineering design team project
- Automotive Engineering research project

* courses are offered in the summer semester (April – July) only

Faculty of Engineering & Computer Science. Exchange students may also be able to take classes from other programmes in this faculty (aeronautical engineering, information engineering, mechanical engineering) if capacity allows.

Department of Aeronautical & Automotive Engineering (September 2024)

Course Name: Introduction to Body in White Design

Degree programme: **Automotive Engineering** (Bachelor)	Responsible Lecturer: Prof. Piskun	
Work load: 150 hours	**Lecture hours per week:** 4	**ECTS Credits:** 5

Course objectives:

Students will

- know the most important car body requirements (functional, legal and consumer-driven)
- understand and can apply legal requirements in order to validate the car body design.
- know the basic car body modules / assemblies and their functions
- know automotive product development phases.

Contents:

- Car body representation in the drawing
- Specialties of car body parts in comparison to machine components in other industries
- Overview of most important car body requirements
- Application of representative legal requirements for design validation
- Fundamentals of car body design; arts of car body structure (steel-stamping, monocoque and space frame), overview of important modules and assemblies (doors and closures, front structure, wiper systems, windshield, etc.)
- Dimensional variation in steel stampings and basic methods to design for precision.
- Design classes on car cabin development (different windshield / side part combinations, development of an A-Pillar accordingly to cross-sections specified etc.)

About didactics and work load distribution:

interactive lectures with exercises; 72 hours classes, 78 hours personal study

Requirements for participation:

Good knowledge of CAD Catia V5 or NX and methods of descriptive geometry.

Type of exam:

written examination, 120 min., paper

Course language:

English

Code for class schedule :

KK1

Requirements for credit point allocation:

Active participation in group work and lessons

Literature:

- Fundamentals of Automobile Body Structure Design, by Donald E. Malen, SAE International, 2011 – Automobiles
- The Automotive Body: Volume II: System Design, Springer, Mar 4, 2011 - Technology & Engineering - 578 pages
- Burandt, U.: Ergonomics for Styling and Design. Dr. Otto Schmidt
- Piskun, A.: Car Body Development Scripts online
- Further Information from industry as lecture scripts from the professor

Course Name: Introduction to Commercial Vehicle Design

Degree programme: **Automotive Engineering** (Bachelor)	Responsible Lecturer: Prof. Dipl.-Ing. Peter Seyfried	
Work load: 150 hours	**Lecture hours per week:** 4	**ECTS Credits:** 5

Course objectives:

Students will

- know commercial and legal requirements for commercial road vehicle concepts
- be able to design a load optimized frame structure of a commercial road vehicle
- know different variants of superstructures and auxiliary frames which are suitable for different types of freight
- be able to develop concepts for load securing and load curves

Contents:

Introduction and overview

Historical development
Road vehicles of today

Conceptual Design of commercial vehicle frame structures

Standards and Specifications
Choice of Materials and semi-finished parts
Production and Joining methods
Profile and node design
Load Assumptions and Calculations
Coupling Systems
Axle systems

Load curves and load securing

Load and loading equipment
Legal requirements and testing procedures
Load curve calculation
Dynamic forces

About didactics and work load distribution:

interactive lectures with exercises; 72 hours classes, 78 hours personal study

Requirements for participation: Completion of courses containing statics, steel material properties and welding	**Course language:** English
Type of exam: Written examination	**Code** for class schedule: NK1

Requirements for credit point allocation:

Active participation in group work and lectures

Literature:

- Hoepke, Breuer (Hrsg.): Nutzfahrzeugtechnik. Springer Vieweg Verlag.
- Lecture slides

Course Name: Introduction to Vehicle Dynamics

Degree programme: **Automotive Engineering** (Bachelor)	**Responsible Lecturer:** Prof. Dr. Fervers

Work load: 150 hours	**Lecture hours per week:** 4	**ECTS Credits:** 5

Course objectives:

The students

- will know the basic terms in vehicle dynamics
- will be able to set the basic effects of tires, handling and suspension into the right context
- will be able to judge about conflicting goals in the setup of vehicle suspension

Contents:

- mechanical structure of an air filled tyre
- force transmission in vertical, longitudinal and lateral direction of tyres
- spring stiffness, damping and rolling resistance of tyres
- longitudinal slip, sideslip angle, pneumatic trail, camber
- basic ideas of rubber to road contact and force transmission
- basic diagrams to characterize tyre behaviour
- one track (bicycle) –model
- basic equations of handling
- steering angel, yaw-angle, side slip angle
- oversteer / understeer
- road holding, limit handling, transition Region
- yaw-gain, critical speed, characteristic speed
- lateral load transfer, anti roll bar, camber, toe
- examples of electronic means to influence driving dynamics
- quarter-vehicle model
- basic equations of ride dynamics
- basic layout of springs and shock absorbers

About didactics and work load distribution:

interactive lectures; 72 hours classes, 48 hours personal study

Requirements for participation: Recommended: Good knowledge in mechanics (statics and dynamics).	**Course language:** English
Type of exam: Written examination; term paper	**Code** for class schedule: FWF

Requirements for credit point allocation:

Active participation in lectures

Literature:

- Reimpell, J. und Betzler, J.W.: Fahrwerktechnik, Grundlagen. Vogel Buchverlag, Würzburg.
- Zomotor, A.: Fahrwerktechnik, Fahrverhalten. Vogel Buchverlag, Würzburg.
- Braess, H.-H. und Seiffert, U.: Handbuch Kraftfahrzeugtechnik. Vieweg, Wiesbaden 2005.
- Dixon, J. C.: Tires, Suspension, Handling. SAE International
- Gillespie, T.: Fundamentals of Vehicle Dynamics. SAE International
- Milliken, W.F. et. Al.: Race Car Vehicle Dynamics, SAE International

Course Name: Drive Train Design

Degree programme: **Automotive Engineering** (Bachelor)		Responsible Lecturer: Prof. Dr. Christoph Grossmann
Work load: 150 hours	**Lecture hours per week:** 4	**ECTS Credits:** 5

Course objectives:

- Students will know the impact relationships of engine, power transmission and vehicle regarding traction power and fuel consumption
- Students will get an introduction to drive train elements and conventional and hybridized drive train architectures of passenger cars, commercial vehicles and mobile machines
- Students will be able to configure and develop drive trains for customer needs

Contents:

1. Overview on vehicle drive trains
2. Combustion engines, tractive power supply and demand
3. Drive train ratio calculation, tractive force chart
4. Gear calculation, tractive power chart, fuel consumption
5. Start-up elements, clutches and torque converter
6. Manual, automated and dual-clutch transmissions, synchronizers and power shift clutches
7. Planetary gear sets – kinematics
8. Planetary gear sets – kinetics and coupled sets
9. Automatic transmissions for passenger cars and commercial vehicles
10. Shift transmissions for commercial vehicles
11. Hydrostatic and continuously variable transmissions
12. Final drive, transfer gear box, differentials, all-wheel drive
13. Hybrid and electric drive trains
14. Drive trains of mobile machines

About didactics and work load distribution:

Interactive lectures with exercises; 72 hours classes, 78 hours personal study

Requirements for participation: Recommended: Basic knowledge of machine elements and vehicle architecture	**Course language:** English
Type of exam: Written examination	**Code** for class schedule: AST

Requirements for credit point allocation:

Active participation in group work, lessons and homework assignment

Literature:

- Naunheimer, H. et al.: Fahrzeuggetriebe. Springer 2007
- Fischer, R. et al.: The Automotive Transmission Book. Springer 2014
- Kirchner, E.: Leistungsübertragung in Fahrzeuggetrieben. Springer 2007
- VDI: Proceedings of the annual conferences “Drivetrain for Vehicles”

Course Name: Finite Element Method (FEM)

Degree programme: **Automotive Engineering** (Bachelor)		Responsible Lecturer: Prof. Dr. Schulte-Bisping
Work load: 150 hours	**Lecture hours per week:** 4	**ECTS Credits:** 5

Course objectives:

The students shall • be able to identify, understand and use different types of mechanical structures; students shall be able to model simple structures mechanically and FE-specifically. • know about and distinguish between different types of analyses. They shall be familiar with statical, stability and natural frequency analyses. • be able to conduct FE computations with NASTRAN. They shall be able to read, to interpret and to visualize the results obtained from those computations. • be familiar with the process of a finite element computation including the different steps. They shall be able to carry out calculations by hand for simple systems consisting of spring or truss elements.

Contents:

- **Introduction and Overview:** Definition FEM (Finite Element Method); FE computation process; FE computation for a system of springs including introduction of technical terms for FE computations.
- **Types of Mechanical Structures:** Mechanical background and corresponding FE-specific parameters are introduced for different types of mechanical structures in solid mechanics, such as: springs, rods, beams, surface structures and three-dimensional structures.
- **Coordinate Systems:** Mechanical structures in different dimensions; coordinate systems; coordinate transformation.
- **Types of Analyses in Solid Mechanics:** Static, stability and natural frequency analyses; presentation of dynamic analyses of frequency response and time response; difference between linear and nonlinear analyses.
- **Selection from the following topics:** Modeling, convergence including h- and p-method, consistent unit systems, derivation of FE-formulation for slabs, numerical integration, locking, computation of heat flow.
- **FEM lab:** Implementation of the aforementioned theoretical topics by way of different exercises using the finite element program NASTRAN.

About didactics and work load distribution:

Interactive lectures, exercises, FEM lab; 72 hours classes, 78 hours personal study

Requirements for participation:

Successful completion of the first year of an undergraduate degree programme in mechanical or automotive engineering; completion of second year recommended.

Course language:

English

Type of exam:

Written examination

Requirements for credit point allocation:

Active participation in lectures and FEM lab exercises

Literature:

- Lecture and Lab notes Handbooks
- NASTRAN: www.mscsoftware.com
- Klaus-Jürgen Bathe, Finite Element Procedures, Prentice Hall

Course Name: Vibration theory & acoustics

Degree programmes: **Aeronautical / Automotive Engineering (Bachelor)**	Responsible Lecturer: Prof. Dr.-Ing. G. Gäbel

Workload: 150 hours	**Lecture hours per week:** 4	**ECTS Credits:** 5

Course objectives:
Students will:

- know the basis phenomena of vibrating systems
- be able to carry out vibration calculations for simple mechanical systems
- know the theoretical principles of the sound field

Contents:

- **Mathematical tools:** real and complex description of harmonic processes, superposition principle, Fourier analysis, spectral description.
- **Setting up equations of motion:** synthetic method (Newton/Euler), Lagrangian equation 2nd kind.
- **Linear oscillator with one degree of freedom:** free vibrations - natural frequency, damping, forced vibrations with harmonic excitation – frequency response, resonance.
- **Linear oscillator with several degrees of freedom:** free vibrations – natural frequencies, natural modes of vibration, harmonic excitation – frequency response, resonance, vibration absorber principle.
- **Theoretical fundamentals of the sound field:** sound fields and sound field quantities, impedance, sound level, airborne sound, structure-borne sound.
- **Perception and measurement of sound:** human hearing, frequency weighting, measurement of sound pressure, sound intensity, sound level.

About didactics and workload distribution:
Interactive lectures with exercises; 68 hours classes, 82 hours personal study

Requirements for participation: Recommended: mathematics, statics, dynamics	**Course language:** English
Type of exam: Written exam	**Code** for class schedule**:** TM4

Requirements for credit point allocation:
Active participation

Literature:

- Lecture notes
- Bottega, William J.: **Engineering Vibrations**, Taylor & Francis Group

Course Name: Engineering Design Team Project

Degree programme: **Automotive Engineering** (Bachelor)	Responsible Lecturer: *	
Work load: 150 hours	**Lecture hours per week:** –	**ECTS Credits:** 5

Course objectives:

Students will work in a team of 3-5 students on a constructional design project in the area of automotive engineering, using their knowledge in mechanics, machine elements and technical drawing.

Contents:

Introduction to the concept-finding and evaluation methods as well as ongoing methodological support will be provided by the lecturer. The solution is worked out by the team.

Team work includes:

- (Self-)Organization and project management
- The definition and illustration of the project task
- The description of the solution
- The necessary analyses and calculations as well as their results
- CAD models and Technical drawings
- A detailed presentation (written report) of the work

About didactics and work load distribution:

150 hours of individual study and project work. The project team will regularly discuss their progress with the lecturer as part of set classes.

Requirements for participation: Successful completion of year 1 of an undergraduate degree programme in automotive or mechanical engineering.	**Course language:** English
Type of exam: Completion and presentation of project as a team, with individual presentations by students.	**Code** for class schedule: IP

Requirements for credit point allocation:

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Literature:

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Notes:

* Students will be coached by the professor responsible for the course.

Course Name: Automotive Engineering Research Project

Degree programme: **Automotive Engineering** (Bachelor)	Responsible Lecturer: *	
Work load: 240 hours	**Lecture hours per week:** –	**ECTS Credits:** 8 **

Course objectives:

Students will work independently on a constructional, experimental or theoretical project in the area of automotive engineering, using scientific methodology and findings.

Contents:

Instruction in the independent completion of a constructional, experimental or theoretical project

A constructional project includes:
- The illustration of the project task
- The description of the solution
- The necessary analyses and calculations as well as their results
- A detailed presentation (written report) of the work

A constructional project also includes:
- The constructional solution

An experimental project also includes:
- The description of the experimental implementation as well as the instrumentation

A theoretical project also includes:
- The explanation of the theoretical analyses and calculations as well as the developed models

About didactics and work load distribution:

240 hours of individual study and project work. Students can choose to complete a project in one of the research areas in the department. This has to be arranged individually with the help of the Departmental Coordinator.

Requirements for participation: Successful completion of year 1 of an undergraduate degree programme in automotive or mechanical engineering.	**Course language:** English
Type of exam: Completion and presentation of project	**Code** for class schedule: PRJ

Requirements for credit point allocation:

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Example of research: AUDEx 1:X automotive development in 1:X using realistic remote-control vehicles
website: www.haw-hamburg.de/en/research/research-projects/project/project/show/audex

Notes:

* Students will be coached by the professor responsible for the research area.

** The workload of this project can be increased to 12 credits, so that together with the other modules it makes up a total semester workload of 30 ECTS.

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