Aeronautical Engineering
- Courses in English* -

- Aerodynamics 2
- Aircraft Design
- Aircraft Engines
- Architecture of the Aircraft Cabin
- Electrical Cabin Systems
- Seminar – Fundamentals of Thermodynamics
- Vibration theory & acoustics
- Industry Design Team Project
- Aeronautical Engineering - Individual 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 (automotive engineering, information engineering, mechanical engineering) if capacity allows.

Department of Aeronautical & Automotive Engineering (March 2025)

Course Name: Aerodynamics 2

Degree programme: **Aeronautical Engineering** (Bachelor)	Responsible Lecturer: Prof. Dr. Rinie Akkermans

Workload: 150 hrs	**Lecture hours per week:** 3 hrs plus 1 hr wind tunnel experiments	**ECTS Credits:** 5

Course objectives:

This course builds on the course Aerodynamics 1 and focuses on wing theory and compressible flows. In Aerodynamics 1 students learned about boundary layer theory and 2d potential flows. Aerodynamics 2 develops these topics to 3d potential flows past wings and to compressible and supersonic flows past aerofoils, wings and through nozzles. On completion of the course students will be able to compute and evaluate the aerodynamic properties of wings and nozzles under various conditions.

Contents:

Students have weekly lectures on the following topics and also complete weekly experimental tasks in the aerodynamics lab (with a small wind tunnel), applying the knowledge from lectures through analysis and reports:

Wing Theory: Wing Geometry, Laws of Vortex Motion, Simplified Horse Shoe Vortex, Elliptic and Arbitrary Wing Loadings, Prandtl's Integral Equation, Induced Drag, Vortex-Lattice-Methods, Swept Wings in Incompressible Flows

One Dimensional Flow: Speed of Sound, Mach Number, Isentropic Flows, Laval Nozzle

Airfoil Theory in Compressible Flows: Linear Theory for Subsonic and Supersonic Flows

Shocks and Waves in steady multidimensional Flows: Normal and Oblique Shocks, Weak Shocks, Expansion Waves, Reflection and Interference

Swept Wings in Compressible Flows: Aerodynamics Characteristics

Transonic Flows: Critical Mach Number, Transonic Airfoils, Flow Characteristics

About didactics and workload distribution:

72 hrs lectures, 78 hrs independent studies: three hours of lectures per week plus one hour of experiments in the wind tunnel lab.

Requirements for participation:

Basics in Fluid Mechanics
Aerodynamics: Boundary Layers, 2d Potential Flows, Thin Airfoil Theory

Type of exam:

Written exam or homework assignment (will be announced at the beginning of the semester)

Course language:

English

Requirements for credit point allocation:

Successful completion of exam and successful participation in wind tunnel lab sessions (lab reports)

Literature:

- Anderson, J. D.: Fundamentals of Aerodynamics, McGrawHill, 2016
- Anderson, J. D.: Modern Compressible Flows: With historical perspective, McGrawHill, 1990.
- Houghton, E. L. et al.: Aerodynamics for Engineering Students, McGrawHill, 2016
- Moran, J.: An Introduction to theoretical and computational aerodynamics, Courier Corporation, 2003.
- Katz, J.; Plotkin, A.: Low-Speed Aerodynamics, Cambridge University Press, 2001

Course Name: Aircraft Design

Degree programme: **Aeronautical Engineering** (Bachelor)		Responsible Lecturer: Prof. Dr. Dieter Scholz
Workload: 150 hours	**Lecture hours per week:** 4	**ECTS Credits:** 5

Course objectives:

- Students will know the technical terms of aircraft design parameters. Furthermore, they know the fundamental relationship of aircraft design parameters.
- Students will be able to design an aircraft (to the detail as covered during the lecture). In addition, they are able to work on specialized areas in aircraft design without assistance, making use of the various sources of information
- Students will be able to structure design activities systematically and efficiently.

Contents:

Introduction and Fundamentals
- Design Sequence
- Requirements and Regulations
- Aircraft Configurations

Preliminary Sizing

Conceptual Design
- Fuselage Design
- Wing Design
- High Lift Systems and Maximum Lift Coefficients
- Empennage Design I
- Weight and Balance
- Empennage Design II
- Landing Gear Integration
- Drag Polar and Drag Prediction
- Design Evaluation; DOC

About didactics and workload distribution:

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

Requirements for participation:

Recommended: Knowledge of aerodynamics, flight mechanics; Completion of courses containing statics and deformable bodies

Type of exam:

Written examination; term paper

Module language:

English

Code for class schedule: FE

Requirements for credit point allocation:

Active participation in group work and lectures and lab

Literature:

- Torenbeek, E.: Synthesis of subsonic airplane design. Dordrecht: Kluwer 1990.
- Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London : Arnold 1996.
- Fielding, J. P.: Introduction to Aircraft Design. Cambridge University Press, 1999.
- Nicolai, L. M.: Fundamentals of Aircraft Design.Xenia, Ohio: METS 1975.
- Pazmany, Ladislao: Light Airplane Design. San Diego, CA: Pazmany 1963.
- Roskam, J.: Airplane Design, Bd. 1-8. Ottawa, Kan.: Roskam Aviation and Engineering Corp., 1989-1997.
  Loftin, L.K.: Subsonic Aircraft: Evolution and the Matching of Size to Performance. NASA Reference Publication 1060, 1980.
- Raymer, D.P.: Aircraft Design: A Conceptual Approach. $. Aufl., Washington: American Institue of Aeronautics and Astronautics, 2006.
- Hiscocks, R.D.: Design of Light Aircraft. Vancouver: Hiscocks, 1995.
- Whitford, R.: Fundamentals of Fighter Design. Ramsbury: Crowood Press 2004.
- Schaufele, R.D.: The Elements of Aircraft Preliminary Design. Sta. Ana: Aries 2000.
- Müller, Friedrich: Flugzeugentwurf: Entwurfssystematik, Aerodynamik, Flugmechanik und Auslegungsparameter für kleinere Flugzeuge. Fürstenfeldbruck, Thomas 2003.
- Howe, D.: Aircraft Conceptual Design Synthesis. London: Professional Engineering Publ. 2000.
- Corke, Thomas C.: Design of Aircraft. Upper Saddle River, NJ: Prentice Hall, 2003.

Course Name: Aircraft Engines

Degree programme: **Aircraft Construction** (Bachelor)	Responsible Lecturer: Prof. Dr. Rinie Akkermans

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

Course objectives:

The students:

- know the principal functions of aircraft engines and corresponding components
- are able to assess the performance of aircraft engines by characteristic parameters
- are able to conduct basic calculations and dimensioning of aircraft engine components
- are able to interpret and to apply the aerodynamic relations for work conversion in aircraft engines

* Virginia Tech students: The class "Seminar – fundamentals of Thermodynamics" is a requirement for credit transfer for AOE 3164 Aerothermodynamics & Propulsion Systems.

Contents:

- **Introduction:** Heat engine as aircraft propulsion system
- **Classification:** Criteria, turbojet, turbofan, turboprop
- **Characteristics:** Thrust, efficiency, specific fuel consumption, flight range
- **Thermodynamic Cycles:** Ideal and real cycles of gas turbines
- **Aircraft engine components:** Construction and mode of operation
- **Non-rotating components:** Subsonic and supersonic inlets, combustion chamber, nozzle
- **Rotating components:** Compressor and turbine, Euler work, efficiency, velocity triangles

About didactics and workload distribution:

Seminar form, blackboard, digital presentation. 72 hours classes, 78 hours independent study

Requirements for participation: Basics in aero-thermodynamics	**Course language:** English **Code** for class schedule: FTW
Type of exam: Written exam	

Requirements for credit point allocation:

None

Literature:

- Kerrebrock, J. L.: "Aircraft Engines and Gas Turbines", 2nd Edition, The MIT Press, Cambridge, Massachusetts, USA, 1992
- Hill, P. G.; Peterson, C. R.: "Mechanics and Thermodynamics of Propulsion", 2nd edition, Addison-Wesley, Reading, Massachusetts, 1992
- Johnsen, I. A.; Bullock, R. O.: "Aerodynamic design of axial-flow compressors — revised", technical report, NASA SP–36, NASA, 1965.
- Cumpsty, N. A.: "Compressor Aerodynamics", Krieger, Malabar, Florida, 2004

Course Name: Architecture of the Aircraft Cabin

Degree programme: **Aeronautical Engineering** (Bachelor)		Responsible Lecturer: Prof. Dr. Gordon Konieczny
Workload: 150 hours	**Lecture hours per week:** 4	**ECTS Credits:** 5

Course objectives:

Students will be taught the fundamental requirements for the design and the operations of an aircraft cabin from the perspectives of different groups, e.g. passengers, carriers, regulatory authorities. They will learn about the basic criteria for the construction of an aircraft cabin and its interdependencies. In addition, they will be able to evaluate current developments and projects in the area of aircraft cabins and cabin systems.

Contents:

1. Introduction to cabin architecture
2. Cabin configurations (Technical design parameters of the aircraft cabin)
3. Human Factors (Anthropometry, Cabin operations, physiological and psychological aspects)
4. Certification of aircraft cabins (Introduction and procedures for basic certification parameters)
5. Airbus site visit – Innovative Cabins
6. Trends in aircraft cabins
7. Overview of functional cabin architecture (Requirements Based Engineering (RBE), Functional Integration, Development Processes (V-Process)
8. Cabin Monuments and components (Description of standard cabin components, detailed examination of seating, galley, toilets)
9. Cabin systems – overview of mechanical and electrical systems as part of the cabin architecture, including basic aspects of cabin acoustics
10. Cargo systems
11. Cabin Flexibility and Reconfiguration
12. Materials and Material tests
13. Configuration Management and Module definition
14. Supplier Strategies and Use of Intellectual Property

About didactics and workload distribution:

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

Requirements for participation:

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Course language:

English

Type of exam:

Written examination, paper

Code for class schedule:
AKA

Requirements for credit point allocation:

Active participation in group work and lessons

Literature:

- Torenbeek, E.: Synthesis of Subsonic Airplane Design.
- Woodson, Wesley et al.: Human Factors Design Handbook.
- Engmann, K. et al.: Technologie des Flugzeugs, Würzburg, Vogel Buchverlag, 4. Auflage 2008.
- Schulze, E. et. al.: Flugmedizin, Berlin, transpress Verlag, 1. Auflage 1990.
- Daab, Ralf: Aircraft Interiors, Köln, fusion publishing GmbH, 1. Auflage 2005.
- Bor, Robert: Passenger Behavior, Hants, Ashgate Publishing House, 1. Auflage 2005.
- Tilley, Alvin R. : The Measure of Man and Woman, Henry Dreyfuss Associates, John Wiley & Sons, Inc. New York, revised edition, 2002.

Course Name: Electrical Cabin Systems

Degree programme: **Aeronautical Engineering** (Bachelor)	Responsible Lecturer: Prof. Dr. Mark Wiegmann

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

Course objectives:

The students

- know about the composition of *Embedded Systems* and are aware of specific features of systems of high availability for safety critical applications and its operations. Furthermore, they can differentiate these from commercial computers (e.g. PCs, Smartphones).
- know the practice of designing complex mechatronic systems being employed in large commercial airliners and know about the roles and responsibilities of involved actors. Based on this they can derive the extra efforts in designing and manufacturing certifiable airborne systems compared to commercial systems.
- are able to extract and understand relevant content from the original official specifications and standards.
- are able to sketch and explain the composition, the functioning and the existing boundary conditions for integration of avionic systems, especially for those to be employed in aircraft cabins.
- have the ability to work as an aircraft architect, integrator or systems engineer by being able to take into account the characteristics of electronic and software-defined aircraft systems while being aware of the necessary efforts for the design and manufacturing of certifiable airborne electronic systems.

Contents:

- **Architecture of Embedded Systems:** Hardware, Software, layered model, real-time systems**,** data busses
- **Avionic design & development processes:** fundamentals systems design, aeronautic certification
- **Aircraft systems - Avionics & Cabin electronics:** Classic and Integrated Modular Avionics, Redundancy and Availability, „*Commercial / Modified Off-The-Shelf*", Cabin Management Systems
- **Wireless Communications with and inside the aircraft:** Satellite Communications, Integration of Mobile Phones and WLAN

About didactics and workload distribution:

interactive lectures with exercises; 108 hours classes, 72 hours personal study

Requirements for participation: Basic university-level courses electrics or electronics	**Course language:** English
Type of exam: Oral examination (30 minutes)	**Code** for class schedule: EKS

Requirements for credit point allocation:

Active participation in group work and lessons

Literature:

- EASA: European Aviation Safety Agency Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes CS-25 , Amendment 14, 2013
- RTCA: DO-254 Design Assurance Guidance for Airborne Electronic Hardware, 2000
- RTCA: DO-178C Software Considerations in Airborne Systems and Equipment Certification, 2011
- SAE: ARP 4754A: Guidelines for Development of Civil Aircraft and Systems, 2010
- Tanenbaum, Wetherall: Computer Networks, Prentice Hall International; Ed. 5., 2013.
- Moir, Seabridge, Jukes: Civil avionics systems, John Wiley & Sons; Ed. 2, 2013

Course Name: Seminar (Fundamentals of Thermodynamics*)

Degree programme: **Aeronautical Engineering** (Bachelor)	Responsible Lecturer: Nemo Juchmann

Workload: 60 hours	**Lecture hours per week:** **2	**ECTS Credits:** 2

Course objectives:

The class allows students to acquire more in-depth knowledge of a special area of aeronautical engineering. The current focus is on the fundamentals of thermodynamics:

- Students will know the fundamental principles of energy conversion and corresponding restrictions.
- Students will be able to calculate the thermodynamic parameters of internal combustion engines.
- Students extend their competences in aeronautical engineering and train their team work capabilities and presentation skills.

* Virginia Tech students: This class (in combination with Aircraft Engines) is a requirement for credit transfer for AOE 3164 Aerothermodynamics & Propulsion Systems.

Contents:

- Thermodynamic systems and state
- Equation of state, ideal gas
- Change of state (isobaric, isochoric, isothermal, isentropic and polytropic)
- Work, heat, enthalpy, heat capacity
- 1st law of thermodynamics: conservation of energy and energy balance
- 2nd law of thermodynamics: entropy, entropy balance, restrictions of energy conversion
- Cycles: ideal (Carnot, Joule/Brayton, Otto and Diesel) and real
- Project management, time scheduling, accomplishment of scientific tasks, presentation techniques.

About didactics and workload distribution:

* Block seminar over 4-5 weeks at the beginning of the semester.

Requirements for participation: Basic engineering knowledge (min. 2 semesters)	**Course language:** English
Type of exam: Written exam or seminar paper	**Code** for class schedule: SEM

Requirements for credit point allocation:

Active participation in group work and lectures.

Literature:

- Heagney, J.: "Fundamentals of Project Management", 5th Ed., McGraw-Hill, 2016
- Perryman, M.: "Scientific Project Management", presentation given at Princeton University, 2013
- Borgnakke, C.; Sonntag, R. E.: "Fundamentals of Thermodynamics", 10th Ed., Wiley, 2019
- Kerrebrock, J. L.: "Aircraft Engines and Gas Turbines", 2nd Edition, The MIT Press, Cambridge, Massachusetts, USA, 1992
- Hill, P. G.; Peterson, C. R.: "Mechanics and Thermodynamics of Propulsion", 2nd edition, Addison-Wesley, Reading, Massachusetts, 1992

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:

The module Vibration Theory and Acoustics is a basic module for the field of Noise Vibration Harshness (NV) and requires successful participation in basic mechanical modules, in particular statics and dynamics. A whole range of mathematical skills are required: Harmonic functions, handling in complex number space, linear algebra, handling and solution behavior with 2nd order differential equations, differential calculus and partial derivatives, harmonic analysis, whereby the latter analysis is discussed in detail in the course. As the fields of vibration theory and acoustics are often inseparable in industrial practice, the course includes an introduction to acoustics. In addition to the sound field, the sound field description, the level calculation, measurement and analysis methods and (if time permits) initial component measures for optimizing the acoustic behaviour are presented.

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: Industry Design Team Project

Degree programme: **Aeronautical Engineering** (Bachelor)	Responsible Lecturer: Prof. Dr.-Ing. J. Abulawi

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

Course objectives:

In a team 3 - 5 students conceive and elaborate a mechanical design solution for an aeronautical engineering design task. They use a methodical approach to identify requirements and define and evaluate various creative concepts. With their knowledge in engineering mechanics, machine elements, materials science, and computer aided engineering (CAD), they elaborate the favorite concept into a detailed design solution. They present and discuss their concepts and their final solution, and document the whole project in a team portfolio. Students are usually given a task by a company such as Airbus. In this case students have the opportunity to present their design to Airbus experts on site at the Hamburg plant.

Contents:

Brief introduction to project management and teamwork. Familiarization with methods for requirements elicitation, concept definition and evaluation. Each team obtains individual ongoing support in the concept and the design phase. On demand, support is offered for aspects of team ork and organization.

Team work includes:

- (Self-)Organization and project management
- Identification of needs and requirements & functional analysis
- Development of at least three concepts with creativity methods & methodical concept evaluation
- Elaboration of one concept into a detailed engineering design solution
- Dimensioning of critical design elements & estimation of weight and cost
- 3D CAD modeling of the design solution with associated technical drawings & bill of materials
- Detailed documentation of the project work
- Interim and final presentation and discussion of concepts and design solutions

About didactics and workload distribution:

150 hours of individual study and project work. The course includes several optional lecture sessions, at least three individual team progress review meetings with the lecturer and two plenum presentation sessions.

Requirements for participation:

Successful completion of year 1 of an undergraduate degree programme in aeronautical or mechanical engineering.

Type of exam:

Completion and presentation of the project as a team, submission of a team portfolio with specific documents (e.g. drawings, calculations) produced by individual students.

Course language:

English

Code for class schedule:
IP

Requirements for credit point allocation:

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Literature:

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Notes:

This course is usually organized in cooperation with design engineers from the local aeronautical industry who offer additional technical support. The practical aspect of the course is supported by excursions to an aircraft manufacturer and to the Aircraft Interiors Expo.

Course Name: Aeronautical Engineering Research Project

Degree programme: **Aeronautical Engineering** (Bachelor)	Responsible Lecturer: *

Workload: 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 aeronautical 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

Project opportunities in aircraft design: http://WorkOffered.ProfScholz.de

About didactics and workload 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. Information about the different projects can be found under: **www.haw-hamburg.de/7092.html**

Requirements for participation: Successful completion of year 1 of an undergraduate degree programme in aeronautical 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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Literature:

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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.