Aeronautical Engineering
- Courses in English* -

- Aerodynamics 2
- Aircraft Design
- Aircraft Engines
- Aircraft Systems
- Architecture of the Aircraft Cabin
- Electrical Cabin Systems
- Mechanical Aircraft Cabin Systems
- Seminar – Fundamentals of Thermodynamics
- Industry Design Team Project
- Aeronautical Engineering - Individual research project

* courses are offered in the summer semester (March – 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 (June 2020)
# Course Name: Aerodynamics 2

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

**Responsible Lecturer:** Prof. Dr. Rinie Akkermans

**Work load:** 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 work load 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)

## Requirements for credit point allocation:
Successful completion of exam and successful participation in wind tunnel lab sessions (lab reports)

## Course language:
English

## Literature:
**Course Name:** Aircraft Design

**Degree programme:** Aeronautical Engineering (Bachelor)  
**Responsible Lecturer:** Prof. Dr. Dieter Scholz

**Work load:** 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.

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**About didactics and work load 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

**Requirements for credit point allocation:**
Active participation in group work and lectures and lab

**Literature:**
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**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 work load 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:**
## Course Name: Aircraft Systems

### Degree programme:
**Aeronautical Engineering** (Bachelor)

### Responsible Lecturer:
Prof. Dr. Dieter Scholz

### Work load:
150 hrs

### Lecture hours per week:
4

### ECTS Credits:
5

### Course objectives:

Students will know:
- the technical German and English terms related to aircraft systems,
- the working principles of aircraft systems,
- the function of aircraft systems of selected aircraft,
- the dependencies among different aircraft systems.

### Contents:

1. Introduction
2. Description of aircraft system principles
3. Description of aircraft system functions of selected aircraft (currently: Airbus A321)

The contents numbered 2 and 3 account for:
- air conditioning
- auto flight
- communications
- electrical power
- equipment / furnishings
- fire protection
- flight controls
- fuel
- hydraulic power
- ice & rain protection
- indicating / recording systems
- landing gear
- lights
- navigation
- oxygen
- pneumatic
- water / waste
- cabin systems
- central maintenance system (CMS)
- information systems
- airborne auxiliary power
- cargo and accessory compartments

### About didactics and work load distribution:

lectures in class, evening lectures with experts, aircraft systems simulator training. 72 hours lectures, 78 hours independent study.

### Requirements for participation:

- 

### Type of exam:

written, closed books

### Requirements for credit point allocation:

Successfully pass the examination, course participation

### Literature:

- Lecture notes on [http://fs.ProfScholz.de](http://fs.ProfScholz.de)
Course Name: Architecture of the Aircraft Cabin

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

Responsible Lecturer: Prof. Dr. Gordon Konieczny

Work load: 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 work load distribution:
Interactive lectures with exercises; 72 hours classes, 78 hours personal study

Requirements for participation:

Type of exam:
Written examination, paper

Requirements for credit point allocation:
Active participation in group work and lessons

Literature:
- Torenbeek, E.: Synthesis of Subsonic Airplane Design.  
# Course Name: Electrical Cabin Systems

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

## Work load:
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, databusses
- **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 work load distribution:

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

## Requirements for participation:
- Basic university-level courses electrics or electronics

## Type of exam:
- Oral examination (30 minutes)

## Requirements for credit point allocation:
- Active participation in group work and lessons

## Literature:
- 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
- Moir, Seabridge, Jukes: Civil avionics systems, John Wiley & Sons; Ed. 2, 2013
### Course Name: Mechanical Aircraft Cabin Systems

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

**Responsible Lecturer:** Prof. Dr. Wolfgang Gleine

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

**Course objectives:**
Students are taught the technical fundamentals and functions of individual fluid mechanical aircraft cabin systems and their interdependencies with other systems and with features of the whole aircraft. They will learn about main parameters required for system operation and system integration into an aircraft. Dependencies between system design/installation and cabin operation and cabin comfort properties (e.g. cabin acoustics, cabin ventilation) are explained in detail.

**Contents:**
- Air conditioning
- Cooling systems
- Water / Waste Water Systems
- Oxygen Systems

**About didactics and work load distribution:**
Interactive lectures with exercises; 108 hours classes, 72 hours personal study

**Requirements for participation:**
Recommended: Knowledge of fluid mechanics, thermodynamics, electronics, measuring and controlling technologies

**Type of exam:**
Written examination

**Requirements for credit point allocation:**
Active participation in group work and lessons

**Course language:**
English

**Code for class schedule:**
MKS

**Literature:**
Information from industry as lecture scripts from the professor
# Course Name: Seminar (Fundamentals of Thermodynamics*)

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## Degree programme:
**Aeronautical Engineering** (Bachelor)  
Responsible Lecturer: Prof. Dr. Dragan Kozulovic

## Work load: 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 Aerothermo-dynamics & 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 work load distribution:
* Block seminar over 4-5 weeks at the beginning of the semester.

## Requirements for participation:
- Basic engineering knowledge (min. 2 semesters)

## Type of exam:
- Written exam or seminar paper

## Requirements for credit point allocation:
- Active participation in group work and lectures.

## Literature:

## Course language:
- English

## Code for class schedule:
- SEM
**Course Name:** Industry Design Team Project

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

| Work load: 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 team work. 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 work 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 work load 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.

**Requirements for credit point allocation:**
–

**Course language:**
English

**Code for class schedule:**
IP

**Literature:**
–

**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

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| 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 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

**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. Information about the different projects can be found under: [www.haw-hamburg.de/7092.html](http://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:**
–

**Literature:**
–

**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.