

ME-445 AERODYNAMICS



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General information

Course details

- **COURSE CODE:** ME-445
- **CREDITS:** 4 ECTS
- **LOCATION:** ELA1
- **TEACHER:** Prof. K. Mulleners
- **TEACHING ASSISTANTS:**
 - Sahar Rezapour, PhD student at UNFoLD 
 - Dr. Artur Gesla, post-doc at HEAD 
 - Marc-Antoine Chevilly, MA3 student at EPFL



4 ECTS correspond to a total expected workload of $4 \times 30\text{h} = 120\text{h}$.
This corresponds e.g. to:
🕒 7h/week **during the semester** +
🕒 22h **during the exam revision period**.

Course summary

This course will provide the fluid dynamic background to understand how air flows around two- and three-dimensional wings and bodies and to understand the aerodynamics forces and moments acting on the objects as a result of the air flow.

Course format

The course is in the form of a **flipped classroom**.

🕒 **In between sessions**

You prepare for the exercise sessions by watching prerecorded videos at your own pace where you want. You can find the videos here [🔗](#). They are grouped in playlists by week.

🕒 **Tuesday 13:15 - 15:00**

You try to solve the exercises for the week in group or on your own in the classroom in presence of the teaching team. Note that we are there to help you solve the questions, not necessarily to give you the answers.

🕒 **Tuesday 15:15 - 17:00**

We meet in the classroom to address questions you have after watching the videos or during the exercises. Depending on the topic of the week, we will discuss more in detail most frequently asked questions or frequently made mistakes, show more concrete examples, or go on excursions looking at current research or events.

If you have questions, please share them on the ED discussion forum [🔗](#)

Course material



Note that there can be variations between the pdfs and the slides used in the videos as we try to update and adapt the course continuously.

■ Lecture slides

can be found on moodle .

You find *one pdf file per topic*. The slides are un-annotated to encourage you to take your own notes while watching the videos.

■ Prerecorded lecture videos

can be found here . They are grouped in playlists by week.

- **Exercise sheets and solutions** can also be found on moodle. They are grouped by the week that you are expected to solve them in class. The pdfs with the solutions to the exercises on a specific *topic* are password protected.

We will share the passwords first in class before the end of the session such that you can verify your results and ask questions before the end of the session. The passwords will be shared later on moodle.

- The main **reference book** for this course is *Aerodynamics for Engineering Students* by Houghton, Carpenter, Collicott, and Valentine. The 6th edition is available online within the EPFL network here , the 7th edition is available in the library.

Further reading

- **Fundamentals of Aerodynamics** by John D Anderson
- **Low-Speed Aerodynamics** by Katz and Plotkin
- **Theory of Wing Sections** by Abbott and von Doenhoff

Other (potentially useful of interesting) links

Blog celebrating the physics of all that flows by Dr. Nicole Sharp



Gallery of videos, images, bicycle aerodynamics, etc.




e fluids

Tool for the design and analysis of subsonic airfoils



Airfoil database 



























Evaluation

- Group project on airfoil characterisation during the semester (30 %) extract airfoil performance data from a journal paper and compare the results with your own calculations using at least 2 out of 3 theories treated during this course (potential flow, thin airfoil theory, Prandtl lifting line). 

More information on the group project will follow in week 7

- Written exam (70 %)
 - closed book exam
 - no notes or other personal material will be allowed
 - the formula sheet will be handed out together with the exam copy
 - calculator allowed
 - the exam will consist of 3 parts
 - multiple choice questions
 - exercises similar to what we will do in class
 - open questions testing your physical understanding of aerodynamic phenomena

Schedule

 Introduction	 Thin airfoil theory (4-6)
Week 1  Dimensional analysis & matlab tutorial	Week 7  Multi-element airfoils
 Basic concepts	 Prandtl's lifting line theory (1-3)
Week 2  Basic aerodynamic calculations	Week 8  Prandtl's lifting line theory
 Potential flow (1-3)	 Prandtl's lifting line theory (4-8)
Week 3  Basic aerodynamic calculations	Week 9  Project work
 Potential flow (4-5)	 Prandtl's lifting line theory (6)
Week 4  General potential flow exercises	Week 10  Project work
 Potential flow (6-8)	 Viscous flows (1-3)
Week 5  Conformal mapping	Week 11  Project work
 Thin airfoil theory (1-3)	 Viscous flows (4-5)
Week 6  General thin airfoil theory	Week 12  Project work
Fall break	Week 13  Project presentations
	Week 14  Project presentations