Fall 2024

ME-445 AERODYNAMICS

00 - General info

K. Mulleners

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
  - Mahbod Mohammadrashidi, PhD student at LFMI

4 ECTS correspond to a total expected work-load of 4 x 30h = 120h.
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**.

before Tuesday 13:15

You prepare for classroom 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 starting at 13:15

We meet in the classroom to discuss questions you have after watching the videos and we solve an example exercise together. This will take approximately 20 minutes.

Tuesday until 15:15

You try to solve exercises in group or on your own in the classroom in presence of teacher and teaching assistants.

Tuesday starting at 15:15

We summarise the main takeaways, discuss pitfalls and the most frequently asked questions, and any remaining questions on the exercises and the lecture material.

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 you 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 solutions to the exercises on a specific *topic* will be posted at the end of all sessions on that topic. This is not necessarily the same week.

- 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.  efluids

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 6

- 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

Week 1	Topic 1: Introduction Dimensional analysis & matlab tutorial
Week 2	Topic 2: Basic concepts Basic aerodynamic calculations
Week 3	Topic 3: Potential flow theory Basic aerodynamic calculations
Week 4	Topic 3: Potential flow theory General potential flow exercises
Week 5	Topic 3: Potential flow theory Conformal mapping
Week 6	Topic 4: Thin airfoil theory Introduction to the group project
Fall break	
Week 7	Topic 4: Thin airfoil theory General thin airfoil theory
Week 8	Multi-element airfoils
Week 9	Topic 5: Finite wings Project progress meetings
Week 10	Topic 5: Finite wings Prandtl's lifting line theory
Week 11	Topic 6: Viscous effects Introduction to flow control
Week 12	Topic 6: Viscous effects Project work
Week 13	Project presentations
Week 14	Project presentations