Aerodynamics1

Syllabus Number 2A202
Basic Major Subjects
Requisites 2 credit
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1. Course Description

Among the fluid dynamics, aerodynamics is the study that deals mainly with the flow around the wings of the airplane.
Because we address the flow around the airplane that flies sufficiently below the speed of sound and the fluid viscosity of the air is low, the air can be treated as non-viscous incompressible flow. In other words, the airflow can be treated as a flow of ideal fluid.
By dealing with the flow around the wings of the aircraft as a stream of ideal fluid, the fundamental law of the forces such as lift generated in the wing has been revealed. The purpose of this course is to understand the flow of the ideal fluid.

2. Course Objectives

The goal of this lecture is to learn the flow of the ideal fluid forming the basis of aerodynamics, and to understand the principle of the lift generated in the wings of the airplane.

3. Grading Policy

Exercises will be given at the end of each lectures, and the answer for these exercises should be reported by the next lecture.
The attendance will be checked by using these reports and the evaluation of this course will be partially done by these reports(20%).
The evaluation of this course will mainly done by the final exam (80%).

4. Textbook and Reference

Textbook
中山泰喜 『新編 流体の力学』ISBN-13: 978-4842504780
養賢堂
Reference
谷一郎 『流れ学』ISBN-13: 978-4000214315 岩波書店
石綿良三 『流体力学入門』ISBN-13: 978-4627671614 森北出版
佐藤恵一、木村繁男、上野久儀、増山豊 『流れ学』ISBN-13: 978-4254231076 朝倉書店

5. Requirements(Assignments)

Read the textbook well in advance. Also, since the next lecture material will be posted on the LMS, read it at the same time (1.5 hours).
I will tell you the scope of the next lecture in the lecture of the previous week.
As written in "Grading Policy", students have to solve the questions and submit the answer by the lecture of the next week (1.5 hours).

6. Note

Anyway, I will give lectures that conform to the textbook. Read the textbook thoroughly and try to understand all the exercises at the end of each chapter.
Regarding the solution to the model and the way to think about it, we will give feedback via lecture at the next week of submission.

7. Schedule

[1] History of fluid dynamics. Properties of fluid (unit and dimension).
[2] Properties of fluid (such as density, viscosity, Newtonian flow, surface tension, compressibility, perfect gas properties).
[3] Fluid statics (pressure, force applied to fluid, Archimedes principle, state of relative stationary).
[4] Basics of flow (stream line, streak line, path line and stream tube, steady flow and unsteady flow, three dimensional flow, two dimensional flow, one dimensional flow, laminar flow and turbulent flow, Reynolds number, incompressible fluid and compressible fluid, fluid rotation and vortex, circulation).
[5] One dimensional flow (Law of conservation of mass, Law of conservation of energy).
[6] One-dimensional flow (continuation - Law of conservation of energy, Law of conservation of momentum, Law of conservation of angular momentum).
[7] Viscous flow (continuity equation, Navier-Stokes equation).
[8] Viscous flow (velocity distribution of laminar flow, velocity distribution of turbulent flow).
[9] Viscous flow (boundary layer, theory of lubrication).
[10] Lift and drag (flow around the body, force acting on the body, drag of the body).
[11] Lift and drag (lift of the body).
[12] Lift and drag (blade cascade, cavitation), dimensional analysis and similarity law (dimensional analysis, π theorem of Buckingham, application example of dimensional analysis, law of dynamical similarity).
[13] Flow of ideal fluid (Euler's equation of motion, velocity potential, stream function, complex potential, example of potential flow).
[14] Flow of ideal fluid (Conformal mapping).
[15] Summary, Examination