

Aerodynamics of Wings

Syllabus Number

2B212

Special Subjects

Elective 2 credit

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1. Course Description

In this course we shall study atmospheric properties, airfoils, lift and moment acting on an airfoil, lift theory, induced drag on 3-dimensional wings, and viscosity and boundary layers.

2. Course Objectives

Airplanes can fly through the air by the lift that is generated by their wings. In order to generate lift effectively, wings are designed to have a cross-sectional shape (airfoil) appropriate to the desired flight speed, and ailerons and other auxiliary systems may also be used according to circumstances. In addition to understanding the principles behind the generation of lift, we must also study the lift coefficient, drag coefficient, and other key design parameters for evaluating the performance of wings. The perfect fluid theory around wings is essential for a quantitative understanding of lift. Finally, students will also learn how viscosity affects the flow around a wing.

3. Grading Policy

It is important to be able to explain the principle of lift generation.

It depends on your understanding of wing concepts, such as how the lift coefficient and drag coefficient that characterize the wing are related to the angle of attack and Reynolds number.

The evaluation of this course will be mainly done by the final exam (80%).

Beside the final exam, each lecture has the time to practice sample problems for promotion of understanding and will be reflected to attendance and partially to the evaluation (20%).

4. Textbook and Reference

Textbook

Textbook: Distribute printed materials.

5. Requirements (Assignments)

In addition to taking notes, read textbooks and reference materials repeatedly until you have a proper physical image. Make it clear what you do not understand, and make an effort to reduce unknown parts by using reference books and questions.

Reference books: Please read about the following books at the library.

Hiroshi Maeda, "The Wings (Yoku no Hanashi)" Yokendo Co., Ltd.

J. D. Anderson, Jr., "Fundamentals of Aerodynamics Fourth Edition", McGraw-Hill

Ichiro Tani, "Flow Science" Iwanami Shoten (library material ID is 423.8 / Ta87.) ISBN-9784000214315

Isao Imai, "Fluid Dynamics" Iwanami Shoten, ISBN-9784000077491

6. Note

7. Schedule

- [1] Nature of the atmosphere
- [2] Wing cross section
- [3] Mechanism of lift generation
- [4] Forces and moments acting on wings, crucial dimensionless numbers
- [5] Center of pressure and aerodynamic center
- [6] Perfect fluid (circulation, stream function, complex velocity potential)
- [7] Perfect fluid (basic flow, Kutta condition)
- [8] Perfect fluid (flow around a two-dimensional object)
- [9] Vortex free flow of perfect fluid (Kutta-Jukowsky's theorem)
- [10] Vortex free flow of perfect fluid (conformal mapping)
- [11] Vortex free flow of perfect fluid (asymmetric wing, vortex sheet)
- [12] Wings and aerodynamics
- [13] Classical thin wing theory
- [14] Drag acting on wings (effect of viscosity, separation of boundary layer)
- [15] Three-dimensional wing, induced drag