

Airframe Structural Design, Basic

Syllabus Number

2B304

Basic Major Subjects

Elective Requisites 2
credit

HIRAMOTO, Takashi

1. Course Description

For aircraft structures, weight reduction is a major goal. In order to achieve its purpose, there are structural methods and design methods suitable for parts and members. The purpose of the lecture is to understand the analysis method of aircraft structural design. In the lecture, we will learn the design method for various structures while paying attention to the load flow and transfer that the aircraft structure designer would think.

In this lecture, students will acquire knowledge and techniques on DP1.

2. Course Objectives

In this course, we will focus on items that are particularly necessary for the structural design of aircraft and the aim is to acquire the basic idea of aircraft structural design.

(1) Section properties of asymmetric cross section can be calculated and internal load can be obtained

(2) Bending and torsion analysis of thin plate structure can be done

(3) It is possible to express internal load distribution by expressing load transfer between members using free body diagram

(4) Understand the calculation method for the compression member (ex. effective width of the reinforcing plate)

(5) Calculate the tension field to evaluate the strength after shear buckling

(6) Understand the idea of fatigue design and damage-tolerance design against repeated load and calculate fatigue strength

3. Grading Policy

It is evaluated according to the task (30%) to be carried out as appropriate and the examination (70%) to be conducted at the end of the term.

The answers and explanations given in the lecture will be shown.

4. Textbook and Reference

Textbook

Text to be used in the lecture will be presented at the LMS.

Reference

J. Niisawa et al. Structural Mechanics of Aircraft,

ISBN 978-4782840740 Industrial Book

S. Kobayashi Aircraft structural mechanics (revised new edition),

ISBN 978-4903814674 Pleiades publication

5. Requirements(Assignments)

This lecture is on the extension of lecture contents of "Introduction to aeronautical engineering", "Solid Mechanics 1 & 2", and "Fundamental Design Technology of an Airplane". Therefore, although it is not mandatory, it is desirable that you take them.

In addition, it is vital that design calculation is actually done by yourself. You cannot understand by reading answers alone. So please try to solve the examples and the tasks by yourself first.

6. Note

7. Schedule

- [1] Basics of structural design: Understand the characteristics of aircraft structure, basic role of structural members
- [2] Load acting on aircraft: Learn the loads imposed during operation of the aircraft
- [3] Section characteristics: Learn about the cross-sectional characteristics of the basic members in considering structural design. Also, consider the stress (bending stress) generated by bending
- [4] Torsion: Consider the twist of the round bar, the thin plate, the closed cross section, and the multi cell structure
- [5] Shear stress due to bending: Learn how to calculate shear stress due to bending of a structure subjected to shear load from a basic biaxial symmetric cross section beam to an airfoil cross section
- [6] Asymmetric Beams: Learn about loading on asymmetric beams that are common in real structures
- [7] Free Body Diagram and Shear Field: Learn about the shear flow of the thin plate and the load distribution of the axial member based on the idea of free body diagram for the typical aircraft structure composed of flange and web
- [8] Curved surface shear field: Solve curved web structure according to shear field theory. Also understand the semi-monocoque structure and box beam analysis method which is a typical aircraft structural style
- [9] Static strength and Bending fracture strength: Learn about concept of static strength in structural design and concept of strength after plasticity of members subject to bending
- [10] Buckling of the compression member (1): Learn buckling calculation used in aircraft design such as practical formula considering plastic buckling and buckling when subjected to lateral load
- [11] Buckling of compression member (2): Learn about compression of reinforcement panel with stiffeners used for main wing skin

- [12] Buckling of compression member (3): Learn the buckling phenomenon and its strength evaluation that occur when compressive load is applied to a column, flat plate, curved plate
- [13] Strength of joint: Learn how to calculate the strength of shear joints and tensile joints used in aircraft construction. And, show the concept of design for adhesive joints
- [14] Tension field: Learn the calculation method of the structural style that shares the shear load with thin plates frequently used for aircraft construction
- [15] Fatigue strength of aircraft structure: Learn the fatigue life calculation method which is the basis of safety life design, and the foundation of fracture mechanics which is the basis of damage tolerance design