Aerospace Control2

Syllabus Number 2C304
Special Subjects
Elective 2 credit
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1. Course Description

This lecture is a sequel to "Automatic Aerospace Control 1" and aims to learn the basics of classical control theory and to deepen the understanding of aircraft control technology. It is recommended to use a training program mainly using the control system analysis software MATLAB.
In this class, you will acquire specialized knowledge about DP2.

2. Course Objectives

・Be able to explain the outline of a general control system for fixed wing aircraft.
・Be able to analyze A controlled system by time response and frequency response.
・Draw a Bode diagram to determine stability.
・Describe the controlled system by expressing it in a state equation and solve them.
・Understand the improvement of control characteristics by compensator using root locus and Bode diagram.
・Understand the characteristics and stabilization of the aircraft longitudinal mption control system using the model equivalent to the actual aircraft.

3. Grading Policy

In class, assignments are issued almost every time, and students must submit their answers. Unless there is an unavoidable reason, it must be submitted by the deadline. (If the situation is unavoidable, please contact the teacher.)
Answers to the questions and answers to the questions will be explained in the next lesson, and the lessons will be understood based on the responses and understanding of the students.
Use LMS for browsing materials. During the lecture, MATLAB will be used for the assignments.
Grades are evaluated based on the final exam (70%) and the answers (30%) to the assignments given during class.
If you do not submit the assignments, it will be difficult to earn credits. Please take it out without fail.

4. Textbook and Reference

Textbook
佐藤 和也, 平元 和彦, 平田 研二　はじめての制御工学　講談社
ISBN 978-4065137475
Reference
宇津井 諭　絵ときでわかる機械制御　オーム社
ISBN 978-4274202872
川田 昌克　MATLAB/Simulinkによるわかりやすい制御工学　森北出版
ISBN 978-4627917217
片柳 亮二　航空機の飛行制御の実際　森北出版
ISBN 978-4627690912
片柳 亮二　航空機の飛行力学と制御　森北出版
ISBN 978-4627690813
加藤 寛一郎、大屋 昭男、柄沢 研治　航空機力学入門　東京大学出版会
ISBN 978-4130610438

5. Requirements(Assignments)

In control engineering, the system characteristics to be controlled are described by mathematical expressions (mathematical models) and analyzed. The control model usually uses a differential equation or an equation obtained by converting it into an algebraic equation by a mathematical transformation called "Laplace transform". In PID control, differentiation and integration are used. On the other hand, in analysis and design based on the "frequency response" of the control system, the relationship between input and output is represented by complex numbers and displayed in a logarithmic graph.
Therefore, an understanding of the basics of differentiation, integration, complex numbers, and logarithms is necessary for understanding the content of the lessons. If you do not understand them well, study these fields.
In order to understand this class, it is necessary to understand the basics of "Automatic Aerospace Control 1" in the first half of the 3rd year, so please review the basics.

Preparation: To inform you of the next lesson schedule, please read the relevant part of the textbook before the next lesson, look up as much as possible of the words you do not understand, put them in a notebook, and start the lesson. (About 1.5 hours)
Review: Almost every class will give you some useful questions to review, so be sure to submit your answers. (About 1.5 hours)

6. Note

It is strongly recommended that students have completed the first three years of "Automatic Aerospace Control 1".
Class content is subject to change depending on progress.

7. Schedule

[1] Review of the basics of control engineering, aerospace automatic control 1

[2] Control system time response (1): 1st order system (standard type, time constant)

[3] Time response of control system (2): 1st-order system (impulse response and step response), 2nd-order system (standard type, impulse response and step response, natural angular frequency, damping coefficient, and response due to differences in damping coefficient values) change of)

[4] Time response of control system (3): roots, poles, zeros, characteristic polynomials, transient characteristics of second-order systems, final value theorem and steady-state deviation, state space representation

[5] Aircraft Motion and Control Technology (1): Expression of Aircraft Axes and Velocity and Angular Velocity, Outline of Control System, Passenger Aircraft Control System, Equation of Motion, Aircraft Motion Mode

[6] Aircraft Motion and Control Technology (2): Stability Augmentation System (SAS)-Longitudinal stability and lateral directional stability

[7] Aircraft motion and control technology (3): Attitude control system, altitude / course control system

[8] Aircraft motion and control technology (4): In-flight simulator, active control technology: CCV control method, fail-safe, reconfigurable control

[9] Frequency response of control system (1): Concept of frequency response, frequency transfer function, gain / phase and periodic waveforms, calculation of complex numbers and logarithms, dB (decibel) expression, how to draw Bode diagrams and their characteristics

[10] Frequency response of control system (2): Bode diagram of basic elements (integration, differentiation, first-order system, second-order system, etc.), relationship between transient response and frequency response, series connection system (synthesis of Bode diagram)

[11] Control system stability (1): feedback system, closed-loop and open-loop transfer functions, internal stability, characteristic polynomial and stability, Nyquist stability discrimination method, phase margin and gain margin

[12] Control system stability (2): PID control, root locus characteristic root and transient response

[13] Control system stability (3): loop shaping method, control characteristics improvement by compensator, change of phase margin / gain margin

[14] Flight Control Design Exercise (1): Understanding the characteristics of a aircraft longitudinal motion control system using a model equivalent to an actual aircraft and stabilizing them

[15] Flight control design exercise (2): Stabilization of longitudinally unstable aircraft