NUAA Course F010103: Aircraft Conceptual Design

Course Syllabus

Introduction

An understanding of the conceptual and preliminary design of aircraft is imperative for the success of any aeronautical engineer working for a prime contractor. Few engineers are directly involved in these stages of the design process. Most work in other specialized technologies that provide contributions to aircraft design and operation. Understanding the significance of their contributions, and the multi-disciplinary optimization that occurs in the design process, in which their contribution of technology is traded against other technologies, is critical to producing a well-rounded aerospace engineer.

Goals and skills

- Understand how the basic aeronautical engineering disciplines are utilized to develop an aircraft conceptual design that will meet a set of prescribed mission capabilities
- Complete a design exercise for a particular set of mission requirements
- Work in a team (of 3 or 4 students) to perform calculations and trade studies that lead to a specific configuration that is described by a 3-view drawing (plus structural layout, landing gear, tip-over margins, cockpit, high lift systems, etc.), a weight and balance summary, preliminary performance data, and associated descriptions
- Present the results in the form of a written report and oral presentation.

Course Objectives

Students will be able to

- Define a set of design requirements and associated mission profile
- Draw an initial sketch of a configuration that is likely to meet the mission requirements, and estimate initial lift/drag ratio
- Estimate the takeoff gross weight and empty weight of this configuration to meet the mission requirements
- Estimate the thrust/weight ratio (T/W) and wing loading (W/S) to meet a basic set of performance requirements
- Define the characteristics of all lifting surfaces
- Define the control surfaces
- Define the fuselage geometry, cockpit, cabin (of passenger-carrying aircraft), or payload bay (of non-passenger-carrying aircraft)
- Define the landing gear and other aircraft systems
- Define the overall load-bearing structure
- Lay out an initial configuration
- Define the propulsion system characteristics and integrate the system into the aircraft configuration
- Estimate group weights and establish the allowable limits of center of gravity travel
- Calculate flight performance consistent with mission requirements
- Perform design trade studies to optimize the configuration.

Required Texts

Raymer, Daniel P., “Aircraft Design: A Conceptual Approach, Fifth Edition”, AIAA Education Series, 2012

Schaufele, Roger D., “The Elements of Aircraft Preliminary Design”, Aries Publications, 2007

Students must also be familiar with the following books:

Currey, Norm, "Aircraft Landing Gear Design: Principles and Practices", AIAA, 1988
Gundlach, Jay, "Designing Unmanned Aircraft Systems: A Comprehensive Approach", AIAA, 2012
Hoerner, S.F., "Fluid-Dynamic Drag", Hoerner Fluid Dynamics, 1965
Küchemann, Dietrich, "The Aerodynamic Design of Aircraft", AIAA, 2012
Nicolai, Leland, and Carichner, Grant, "Fundamentals of Aircraft and Airship Design, Volume 1 - Aircraft Design", AIAA, 2010
Nicolai, Leland, and Carichner, Grant, "Fundamentals of Aircraft and Airship Design, Volume 2 - Airship Design and Case Studies", AIAA, 2012
Niu, Michael, "Airframe Structural Design", Conmilit Press, 1988
Obert, Ed, "Aerodynamic Design of Transport Aircraft", IOS Press, 2009
Roskam, Jan, "Aircraft Design" (Vols I through VIII), Roskam Aviation and Engineering Corp., 1985
Shevell, Richard, "Fundamentals of Flight", Prentice Hall, 1983
Torenbeek, Egbert, "Synthesis of Subsonic Aircraft Design", Delft University Press, 1982
Whitford, Ray, "Design for Air Combat", Jane's Publishing, 1987

Grades

Grade scores will be determined as follows:

Homework and open book exam	Atmosphere, aircraft design and performance	25%
Design project	Application of conceptual design methods	50%
Closed book exam	Understanding of conceptual design methods	25%

Results of the design project will be presented in the form of an oral presentation and detailed report.

The final grade will be on a pass/fail basis. The pass cutoff score will be at the judgment of the instructor in consultation with faculty advisors.