# Advanced aircraft design and certification II

**Academic Year: ( 2023 / 2024 )** **Review date: 02-11-2022**

**Department assigned to the subject: Aerospace Engineering Department**

**Coordinating teacher: CAVALLARO , RAUNO**

**Type: Compulsory ECTS Credits : 6.0**

**Year : 2 Semester : 1**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Advanced Aircraft Design and Certification I
Advanced Aeroelasticity
Propulsion Systems Performance and Design

It is needed to have a good knowledge, at grade-level, of:
Aerodynamics
Flight Mechanics

## OBJECTIVES

When concluding the course the student must be capable of:
- Sizing the aircraft based on its mission and the adequate flying qualities criteria.
- Calculating the design structural loads acting on the aircraft, as well as the fatigue conditions. Based on this, to estimate the structural and operational weights.
- Knowing the aircraft certification requirements and specifying the means of compliance associated to them, judging their levels of acceptance.
- Specifying the means or tests necessary to demonstrate that the aircraft fulfills the certification requirements.
- Knowing and specifying and/or designing the subsystems of the aircrafts.
- Evaluating the operational costs of the aircraft.
- Evaluating the interaction between systems, flying qualities and structural loads, including failure cases.
- Knowing the specific design constraints of special aircraft types.

## DESCRIPTION OF CONTENTS: PROGRAMME

Aircraft Sizing Review --> Wing Design, Wing Control Surfaces, Fuselage and Tails, Quick Mass Sizing and P/L-Range.

Powerplant selection and installation --> Engine Types, Thrust Requirements, Integration of Jet Engines, Integration of Propeller Engines, Propeller Analysis.

Longitudinal Flying Qualities and HTP design --> Introduction & common A/C tail configurations, HTP main functions, Tail architecture, Basic design guidelines, Longitudinal stability and control, Horizontal tail sizing in preliminary design.

Latero-Directional Flying Qualities and VTP design --> VTP main functions & common A/C tail configurations, VTP architecture, Basic design guidelines, Lateral-directional stability and control, Tail sizing in preliminary design.

Flight Loads --> General Loads Concepts, Design Envelopes, Balanced NZ manoeuvres, Discrete Gusts, Pitch manoeuvres, Roll manoeuvres, Yaw and OEO manoeuvres.

Landing Gear design --> Wheel suspension system, Landing gear retraction, Geometric design criteria, Equivalent single wheel load, Runway classification: LCN/LCG system.

Ground Loads --> Ground Loads Conditions, Landing Loads, Ground Handling Loads, Global Effects and Special Cases.

Fatigue analysis --> Fatigue concept, Infinite-life, Safe-life, Fail-safe, Damage Tolerant: Accidents that changed aerospace engineering, The fatigue design Philosophy, Fatigue Analysis.

Aircraft Mass and CG Estimation --> Overview, Aircraft Mass Breakdown, Rapid Mass Estimation Method, Semi-empirical Mass Estimation Method, CG and Moments of Inertia.

Interaction Systems-Flight-Structures --> Aircraft Systems, Flight Control Systems and Flight Control Laws, Analysis of Systems Failures.

Introduction to Helicopters.

## LEARNING ACTIVITIES AND METHODOLOGY

LEARNING ACTIVITIES

AF1 - Theory sessions.
AF2 - Problem sessions working individually and in groups.
AF3 - Lab sessions in computer rooms.
AF5 - Student's Individual work
AF6 - Tutorial sessions
AF7 - Midterm and final exams

METHODOLOGY

MD1 - Class lectures by the professor with the support of computer and audiovisual media, in which the main concepts of the subject are developed and the bibliography is provided to complement the students' learning.

MD2 - Critical reading of texts recommended by the professor of the subject: press articles, reports, manuals and/or academic articles, either for later discussion in class, or to expand and consolidate the knowledge of the subject.

MD3 - Resolution of practical cases, problems, etc. posed by the teacher individually or in groups.

MD5 - Preparation of papers and reports individually or in groups.

## ASSESSMENT SYSTEM

| | |
|---|---|
| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

SE1 - Continuous assessment including individual or group work, internship reports, mid-term exams.
SE2 - Final exam

Continuous evaluation (40%)
End-of-term exam (60%)

In order to pass the subject a mark of 5.0/10 (Continuous evaluation + End-of-term exam) must be obtained.
It is necessary to have a minimum mark of 4.0/10 in the end-of-term exam to pass the subject.

## BASIC BIBLIOGRAPHY

- Ajoy Kumar Kundu Aircraft Design, Cambridge Aerospace Series, 2010

- Daniel P. Raymer Aircraft Design: A Conceptual Approach, AIAA Education Series, 2012

- J. Gordon Leishman.  Principles of Helicopter Aerodynamics, Cambridge University Press, 2002

- Jan Roskam Airplane Design I-VIII, DAR corporation, 1985-1990

- Ralph D. Kimberlin Flight Testing of Fixed-Wing-Aircraft, AIAA Education Series, 2003

- Ted L. Lomax Structural Loads Analysis for Commercial Transport Aircraft , AIAA Education Series, 1996

## ADDITIONAL BIBLIOGRAPHY

- Bramwells, A.  Helicopter Dynamics , AIAA Education Series, 2001

- Denis Howe Aircraft Conceptual Design Synthesis, Professional Engineering Publishing Limited, 2000

- Denis Howe Aircraft Loading and Structural Layout, AIAA Education Series, 2004

- Egbert Torenbeek Synthesis of Subsonic Airplane Design, Delft University Press, 1982

- Leland M. Nicolai, Grant E. Carichner Fundamentals of Aircraft and Airship Design, Vol 1 - Aircraft Design, AIAA Education Series, 2010

- Lloyd R. Jenkinson, Paul Simpkin, Darren Rhodes Civil Jet Aircraft Design, AIAA Education Series, 1999

- Steven A. Brandt; Randall J. Stiles; John J. Bertin; Ray Whitford Introduction to Aeronautics: A Design Perspective, AIAA Education Series, 2015