Course guide
220343 - 220343 - Advanced Propulsion

Last modified: 02/04/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 220 - ETSEIAT - Terrassa School of Industrial and Aeronautical Engineering.

Degree: MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Manel Soria Guerrero

Others:

PRIOR SKILLS

Previous concepts include knowledge of Thermodynamics and Propulsion systems for aircraft and spacecraft, given in any bachelor's degree in aerospace engineering and reviewed in previous subjects of this Master's degree, as well as familiarity with the use of computing tools for engineering. Good knowledge of at least one computer language (C, Matlab, Python..) is required, as most of the exercises involve code development and verification.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEPROP1. MUEA/MASE: Sufficient applied knowledge of aspects of measurement, calculation and numerical resolution in experimental and computational aerodynamics (specific competency for the specialisation in Propulsion).
CEEPROP2. MUEA/MASE: Advanced applied knowledge of the design, manufacture and maintenance of propulsion systems (specific competency for the specialisation in Propulsion).

TEACHING METHODOLOGY

Lectures and hands-on sessions to solve problems with the help of computers.

LEARNING OBJECTIVES OF THE SUBJECT

-Understand the fundamental principles and the limitations of advanced propulsion technologies.
-Understand the key practical issues associated with the testing of new propulsion and energy storage devices.
-Have adequate knowledge of the current state of electric propulsion for manned and unmanned aircraft, its potential and limitations.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	30,0	24.00
Hours small group	15,0	12.00

Total learning time: 125 h

CONTENTS

Module 1: Introduction to electric aircraft.

Description:
-History, scope and advantages of electric propulsion.
-Tools for preliminary design.
-Aerodynamics of propellers.
-Introduction to electric motors for aircraft.

Full-or-part-time: 41h
Theory classes: 10h
Practical classes: 5h
Self study : 26h

Module 2: Batteries for aerospace applications

Description:
Energy storage: technologies, capacity, charge/discharge cycles, safety, practical aspects.
Models for Lithium-Ion batteries.
Case study: manned and unmanned aircraft with electric propulsion.
Case study: perpetually flying machines.
Case study: the Dragonfly mission to Titan.
Case study: the Ingenuity Drone on Mars.

Full-or-part-time: 41h
Theory classes: 10h
Practical classes: 5h
Self study : 26h

Module 3: Project

Description:
Working in groups, the students will carry out the preliminary design of a fully electric aircraft. They must consider all the propulsion system (batteries, propellers, wiring, cooling systems, etc). They are expected to develop software tools in order to analyse different design variants.

Full-or-part-time: 43h
Theory classes: 10h
Practical classes: 5h
Self study : 28h

GRADING SYSTEM

Class participation and class exercises: 30%
Assignments: 30%
Project: 40%
Students with a grade below 5 in the project, or the assignments, or the classroom participation, will be able to take an additional written exam covering all the subject, which will take place on the date fixed in the calendar of final exams. The grade obtained in this exam will range between 0 and 10, and will replace the part or parts below 5 only in case it is higher, up to a maximum of 5 points.

BIBLIOGRAPHY

Basic:
- Datta, L.V.; Guven, U. Introduction to nanosatellite technology and components: applications of cubesat technology. Saarbrücken: Lap Lambert Academic Pub, 2012. ISBN 9783847314196.
- Horowitz, P.; Hill, W. The art of electronics. 3rd ed. New York: Cambridge University Press, 2015. ISBN 9780521809269.
- Saravanamuttoo, H. I. H. [et al.]. Gas turbine theory. 6th ed. Harlow, England; New York: Pearson Prentice Hall, cop. 2009. ISBN 9780132224376.
- Venkatesh, B. J. Design and performance evaluation of a propeller: design and performance evaluation of a propeller for micro-air vehicle application. Saarbrücken: Lap Lambert Academic Pub, 2012. ISBN 9783847370116.
- Dixon, S.L.; Hall, C.A. Fluid mechanics and thermodynamics of turbomachinery [on line]. 7th ed. Oxford: Butterworth-Heinemann, 2014 [Consultation: 27/07/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780124159549/fluid-mechanics-and-thermodynamics-of-turbomachinery. ISBN 9780124159549.
- Weicker, Phillip. A systems approach to lithium-ion battery management [on line]. Norwood, MA: Artech House, 2014 [Consultation: 03/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1463546. ISBN 9781608076598.