Last update: 05-10-2018

220340 - Extension of Rocket Engines

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering

Teaching unit: 220 - ETSEIAT - Terrassa School of Industrial and Aeronautical Engineering

Academic year: 2018

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

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Manel Soria Guerrero
Oriol Lizandra Dalmases

Prior skills

Previous concepts include knowledge of 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.

Degree competences to which the subject contributes

Specific:

CEEPROP2. MUEA/MASE: Advanced applied knowledge of the design, manufacture and maintenance of propulsion systems (specific competency for the specialisation in Propulsion).
CEEAEROP1. MUEA/MASE: The ability to analyse airport operations, planning and air transport (specific competency for the specialisation in Airports).

Teaching methodology

Classroom lectures combined with assignments to be solved during the class with the help of the professor

Learning objectives of the subject

Understand advanced concepts of rocket engines design such as cooling, propellant feeding methods, instabilities and nozzle design.
Acquire a hands-on experience on experimental testing of small scale rocket engines with gas, solid and hybrid propellants
Understand the fundamentals of cryogenic propellants

Study load

Total learning time: 125h	Hours large group:	30h	24.00%
	Hours small group:	15h	12.00%
	Self study:	80h	64.00%

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Content

Module 1: Nozzle design. Method of characteristics

Learning time: 14h

Theory classes: 3h
Practical classes: 1h
Self study : 10h

Description:
Analysis of design of rocket nozzles using the method of characteristics.

Module 2: Nozzle cooling. Liquid cooling, ablation cooling, thermal inertia

Learning time: 15h

Theory classes: 3h
Practical classes: 2h
Self study : 10h

Description:
Liquid cooling
Ablation cooling
Thermal inertia cooling
Development of simulation software.

Module 3: Cryogenic propellants

Learning time: 16h

Theory classes: 4h
Practical classes: 2h
Self study : 10h

Description:
Evaluation of propellants properties.
Cryogenic cycles.
Main safety issues.

Module 4: Propellant feeding methods. Pressure feed, turbopump based cycles. Steady-state and transient behaviour

Learning time: 16h

Theory classes: 4h
Practical classes: 2h
Self study : 10h

Description:
Pressure feed systems
Turbopump based cycles.
Steady-state and transient behaviour

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Module 5: Combustion instabilities

Learning time: 16h

Theory classes: 4h
Practical classes: 2h
Self study : 10h

Description:
Fundamental aspects
Modelling of instabilities

Module 6: Modelling of solid propellant rockets

Learning time: 16h

Theory classes: 4h
Practical classes: 2h
Self study : 10h

Description:
Modelling pressure transients in combustion chamber.
Computational geometry tools for the prediction of burning profiles.
Two dimensional and three dimensional grain profiles.

Module 7: Rocket trajectories

Learning time: 16h

Theory classes: 4h
Practical classes: 2h
Self study : 10h

Description:
Trajectory modelling
Gravity turn
Coupling between engine and trajectory analysis.

Module 8: Rocket testing and instrumentation

Learning time: 16h

Theory classes: 4h
Practical classes: 2h
Self study : 10h

Description:
Load-cells
Telemetry
Ignition systems
Measuring solid fuel burning rates.

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Qualification system

Assignments 30%
Project 40%
Exam 30%
Students with a grade below 5.0 in the assignments and / or the project, will be able to do an additional exam in order to compensate for the poor results. The new grade will replace the original only if it is higher. The maximum grade that can be obtained with this additional exam is 5.0.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0

Bibliography

Basic:

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Date, Anil W. Analytic combustion: with thermodynamics, chemical kinetics, and mass transfer. 1st paperback ed. New York: Cambridge University Press, 2014. ISBN 9781107448698.

Sutton, G.P.; Biblarz, O. Rocket propulsion elements [on line]. 8th ed. New York: John Wiley & Sons, cop. 2010 [Consultation: 17/11/2016]. Available on: <http://site.ebrary.com/lib/upcatalunya/detail.action?docID=10501307>. ISBN 9780470080245.

Huzel, D.K.; Huang, D.H.; Arbit, N. Modern engineering for design of liquid-propellant rocket engines. Washington: American Institute of Aeronautics and Astronautics, cop. 1992. ISBN 9781563470134.

Horowitz, P.; Hill, W. The art of electronics. 3rd ed. New York: Cambridge University Press, 2015. ISBN 9780521809269.