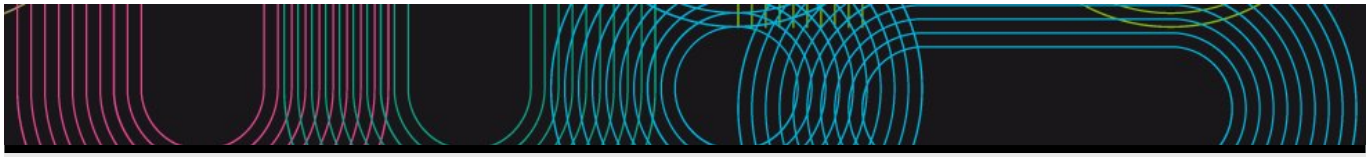

IDENTIFYING DATA				
Propulsion systems				
Subject	Propulsion systems			
Code	O07G410V01945			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Ulloa Sande, Carlos			
Lecturers	Ulloa Sande, Carlos			
E-mail	carlos.ulloa@uvigo.es			
Web	http://aero.uvigo.es			
General description	The matter treats on the problems of development of the systems of propulsion used in aircraft and missiles. The systems of aeronautical and space propulsion are required to make a big variety of missions, covering from the very small push during several years of performance, characteristic of some systems of propulsion employed in satellites, until the very big push acting during time very short, like the thrusters of a space launcher or of an intercontinental ballistic missile. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Capabiliity for design, development and management in the field of aeronautical engineering (in according with what is established in section 5 of order CIN / 308/2009), aerospace vehicles, aerospace propulsion systems, aerospace materials , airport infrastructures, air navigation infrastructures and space management, air traffic and transport management systems.
C29	Appropriate knowledge applied to engineering: concepts and laws that govern the internal combustion, its application to rocket propulsion.
C33	Applied knowledge of aerodynamics, flight mechanics, air defense engineering (ballistics, missiles and air systems), space propulsion, material science and technology, structure theory.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
D6	Capabiliity for interpersonal communication
D8	Capabiliity for critical and self-critical reasoning
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies
D13	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources

Expected results from this subject	
Expected results from this subject	Training and Learning Results

- To know the propulsive needs of the aircraft.	A2 A3 A5	B1	C29 C33	D3 D4 D5 D6 D8 D11 D13
- To know the thrusts and resistances related to the jet engines.	A2 A3 A5	B1	C29	D3 D4 D5 D6 D8 D11 D13
- To know and quantify in an applied way the combustion process of the jet engines and the combustion efficiency.	A2 A3 A5	B1	C29	D4 D5 D8 D11 D13
- To know how to perform an energy balance by differentiating and calculating the returns involved.	A2 A3 A5	B1	C29	D4 D5 D8 D11 D13
- To know how to solve problems related to the calculation of thermodynamic cycles and the characteristics of the jetreactors; as well as the effect of the characteristics and quality of the components.	A2 A3 A5	B1	C29	D4 D5 D8 D11 D13
- To know the different jet engines and know how to obtain the optimal systems from the point of view of propulsive.	A2 A3 A5	B1	C29	D3 D4 D5 D11 D13
- To size the components that intervene in the propulsive system.	A2 A3 A5	B1	C33	D4 D5 D8
- To use computer tools to calculate the performance of air-reactors.	A2 A3 A5	B1	C29	D4 D5 D8
- To know the effect of flight conditions: speed and altitude in the operation of the air-reactors.	A2 A3 A5	B1	C33	D4 D8
- To know the environmental problems of the jet engines and their possible solutions.	A2 A3 A5	B1	C29	D4 D13
- To write technical reports and make oral technical presentations related to the above.	A2 A3 A5	B1	C29 C33	D3 D6 D8 D11 D13
- To solve problems derived from the field of the subject in an autonomous way and in collaboration with others.	A2 A3 A5	B1	C29 C33	D5 D6 D8
- Knowledge and understanding of the laws that govern the movement of vehicles propelled with rocket engines; the generation of thrust and the variables on which it depends.	A2 A3	B1	C29	D4 D8
- Knowledge, understanding, application and analysis of the ideal model of the rocket engines with fluid dynamics propulsion and the influence of real effects.	A2 A3 A5	B1	C29 C33	D4 D5 D8
- Knowledge of the propellants and understanding and the combustion process of the rocket motors of solid, liquid and hybrid propellants.	A2 A3 A5	B1	C29	D4 D8
- Knowledge, understanding, application and analysis of the ionization and acceleration system of electric rocket motors.	A2 A3 A5	B1	C33	D4 D8
- Knowledge, understanding, application and analysis of the feeding and cooling systems.	A2 A3 A5	B1	C33	D4 D8

- To train to understand and simulate the physical-mathematical processes of rocket engines and to address both the problem of actions such as the synthesis or design.	A2 A3 A5	B1	C29 C33	D4 D5 D8

Contents

Topic	
Block 1: Introduction	Unit 1.1: Introduction to aircraft propulsion systems. Unit 1.2: Alternative engines. Unit 1.3: Turbo-propeller and turbo-shaft.
Block 2: Rockets	Unit 2.1: Introduction Unit 2.2: Description and operating principles Unit 2.3: Chemical rockets Unit 2.4: Electric propulsion
Block 3: Turbojet and turbofan	Topic 3.1: Turbojet and turbofan Engine Overview Topic 3.2: Operation of the jet engine Topic 3.3: Intake diffusers Topic 3.4: Compressors Topic 3.5: Combustion chambers Topic 3.6: Turbines Topic 3.7: Nozzles Topic 3.8: Parametric analysis of turbojet and turbofan

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	0	28
Laboratory practical	12	6	18
Seminars	0	2	2
Previous studies	0	79.5	79.5
Mentored work	10	10	20
Objective questions exam	2.5	0	2.5

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Classroom lectures
Laboratory practical	Labs with different propulsion systems Simulation labs of propulsion systems Essays assignments on propulsion systems
Seminars	Tutoring in small groups
Previous studies	Autonomous work
Mentored work	Mentored work

Personalized assistance

Methodologies	Description
Seminars	Small group tutoring with the teachers of the subject. The tutorials will be held, by appointment, in the theacher's office or in the teacher's virtual office, on the Remote Campus.

Assessment

	Description	Qualification	Training and Learning Results			
Laboratory practical	Laboratory report	10	A2 A3 A5	B1	C29 C33	D3 D4 D5 D6 D8 D11 D13

Mentored work	Reports and presentations of the work proposed during the course of the course within the practical sessions	20	A2 A3 A5	B1	C29 C33	D3 D4 D5 D6 D8 D11 D13
Objective questions exam	Partial exam of short questions and problems (30%) (Percentage can be divided into shorter tests) Final exam of short questions and problems (40%)	70	A2 A3 A5	B1	C29 C33	D3 D4 D5 D8 D11 D13

Other comments on the Evaluation

First Call:

(1) Students who follow the course by Continuous Assessment:

In order to pass the subject at the first call, through Continuous Assessment, it will be necessary:

-A grade in the Continuous Assessment final exam of at least 5.0.

-Attend at least 80% of the practical sessions.

-Submit all the practical reports and assignments for the subject, obtaining at least a grade of 3 in each of them.

In the case of not meeting these conditions, the final mark will be the result of the minimum of the average mark of EC and 4.9.

Continuous assessment tests will be carried out during school hours, whenever possible. The final Continuous Assessment exam will be held on the date approved by the center for the first call.

(2) Students who wish to be evaluated by exam-only assessment:

The evaluation of the course at the first call will be carried out, by default, through Continuous Assessment. The student body has the right to opt for the exam-only assessment according to the procedure and the period established by the center for each call, which may not exceed one month.

The grade obtained in this exam will represent 100% of the final grade. The student must obtain a minimum grade of 5.0 in this exam. This exam may have a part to be taken in a computer room and/or laboratory, and will include all of the material taught, as well as the content covered in all the practical sessions and assignments.

The exam-only assessment exam will be carried out on the date approved by the center for the first call.

Second call and end-of-program call:

Students who have not passed the subject at the first call may take an exam that will account for 100% of the final grade. The student must obtain a minimum grade of 5.0 in this exam. This exam may have a part to be taken in a computer room and/or laboratory, and will include all of the material taught, as well as the content covered in all the practical sessions and assignments.

The second call and end-of-program exams will be held on the dates approved by the center for each call.

Other considerations:

In case of detection of plagiarism in any qualification element, the qualification in said item will be 0 and the fact will be communicated to the direction of the Center for the appropriate effects.

The evaluation test schedule officially approved by the Board of the EEAE Center is published on the website http://aero.uvigo.es/es/docencia/examenes

Sources of information

Basic Bibliography

B. Galmés, **Motores de reacción y turbinas de gas**, 2, Paraninfo, 2018

J.D. Mattingly, **Elements of Propulsion: Gas Turbines and Rockets**, 2, AIAA Education Series, 2016

M. Cuesta, **Motores de reacción**, 9, Paraninfo, 2001

Complementary Bibliography

Y. Cengel, **Themodynamics: An engineering approach**, 9 in SI, McGraw-Hill, 2019

Recommendations

Subjects that it is recommended to have taken before

Aerospace technology/O07G410V01205
Fluid mechanics/O07G410V01402
Thermodynamics/O07G410V01303
Fluid mechanics II and CFD/O07G410V01922