# Universida<sub>de</sub>Vigo

Subject Guide 2023 / 2024

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007G410V01945						
Grado en						
Ingeniería						
Aeroespacial						
ECTS Credits	Choose	Year	Quadmester			
6	Optional	4th	1st			
#EnglishFriendly						
Spanish						
Ulloa Sande, Carlos						
Ulloa Sande, Carlos						
carlos.ulloa@uvigo.es						
http://aero.uvigo.es			_			
The matter treats on the problems of development of	the systems of p	propulsion used in	n aircraft and missiles.			
scription 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 r	equest from the	teachers: a) reso	ources and bibliographic			
references in English, b) tutoring sessions in English,	c) exams and as	sessments in Eng	jlish.			
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# **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 Capability 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	A2	В1	C29	D4	
to address both the problem of actions such as the synthesis or design.	А3		C33	D5	
	Α5			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

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

Methodologies	
. removeregies	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	Qualification Training and Learning Results		
Laboratory practical	Laboratory report	10 A A A	3 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/007G410V01402 Thermodynamics/O07G410V01303 Fluid mechanics II and CFD/007G410V01922