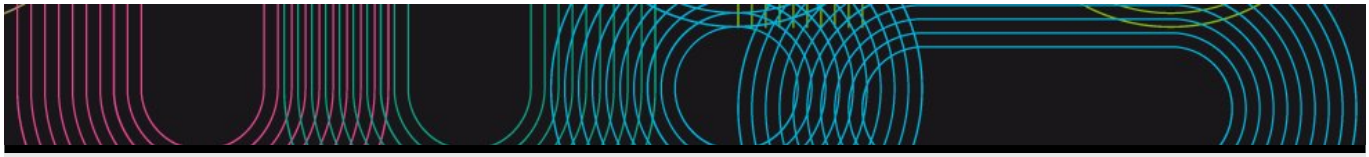

IDENTIFYING DATA				
Propulsion systems				
Subject	Propulsion systems			
Code	O07G410V01945			
Study programme	(*)Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Ulloa 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. ateria del programa English Friendly: Los/as estudiantes internacionales podrán solicitar al profesorado: a) materiales y referencias bibliográficas para el seguimiento de la materia en inglés, b) atender las tutorías en inglés, c) pruebas y evaluaciones en inglés.			

Competencies	
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

Learning outcomes	
Expected results from this subject	Training and Learning Results

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

Contents

Topic
-Propellent needs of aircraft.
-Analysis of the cycle of a turbojet.
-Application of the integral equations of Fluid Mechanics to the Air-Reactors: Continuity: mass expense; Movement amount: thrusts and resistances; Energy: yields
- Engine behaviour and propeller of the air-reactors.
-Turboprops and its optimization
-Turbofans and its optimization; turbofans of mixed flow; advanced turbofans.
- Increasing push systems.
- Gas turbines.
- Component performances.
- Actuations of turbojets.
- Environmental problems derived from the operation of the air-reactors.
- General introduction: historical evolution, current status and future perspectives.
- Propulsive and thermodynamic study.
- Study of the expansion process in rocket engines with fluid dynamics propulsion.
- Solid propellant rocket engines: propellants, combustion process, performances and design fundamentals.
- Rocket engine of liquid and hybrid propellants: propellants, combustion process, power and cooling system, actions and criteria of design.
-Electric power: study of the ionization and acceleration system, propellants and power.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	0	28
Laboratory practical	12	0	12

Seminars	0	2	2
Previous studies	0	79.5	79.5
Objective questions exam	2.5	0	2.5
Practices report	0	6	6
Essay	10	10	20

*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

Personalized assistance

Methodologies	Description
Seminars	Tutoring in small groups

Assessment

	Description	Qualification	Training and Learning Results			
Objective questions exam	Partial exam of short questions and problems (20%) Final exam of short questions and problems (50%)	70	A2 A3 A5	B1	C29 C33	D3 D4 D5 D8 D11 D13
Practices report	Lab classes report	10	A2 A3 A5	B1	C29 C33	D3 D4 D5 D6 D8 D11 D13
Essay	Reports and presentations of essays proposed throughout the course during the lab sessions	20	A2 A3 A5	B1	C29 C33	D3 D4 D5 D6 D8 D11 D13

Other comments on the Evaluation

To pass the subject in in the first and second exam calls it is necessary to obtain an average grade of 5 points over 10 in the required evaluation of ongoing assessment during the year and official exam (scheduled by school). The final grade is computed using the percentages indicated. The calendar of evaluation tests is approved officially by the Board of the EEAE School and it is uploaded to the webiste: http://aero.uvigo.es/gl/docencia/exames

It will be mandatory to take the extraordinary exam of all the contents of the subject, which will be 100% of the grade, in the following cases:

- The non-execution or delivery of any of the previous points.

- Obtain a grade below 4 points out of 10 in the final continuous assessment exam.

The maximum length of the tests is 3 hours if there is not interruption or 5 hours if there is an intermediate pause (with 3 hours as maximum time for each part).

Students that resign officially to the ongoing assessment: the grade obtained in a corresponding test which is represents 100% of assessment. This test could have a part to be made in computer classroom and/or laboratory representing 10% of the final grade.

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