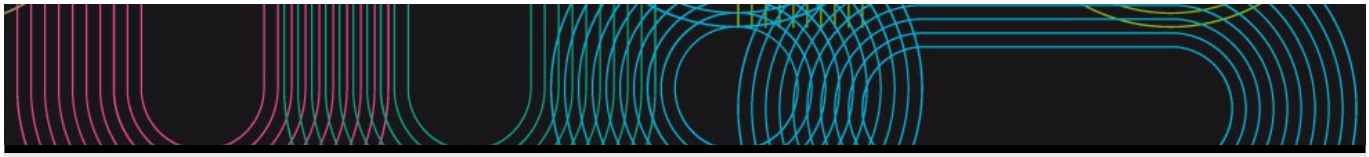

IDENTIFYING DATA				
Analytic and orbital mechanics				
Subject	Analytic and orbital mechanics			
Code	O07G410V01943			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Tommasini , Daniele			
Lecturers	Tommasini , Daniele			
E-mail	daniele@uvigo.es			
Web	http://faitic.uvigo.es/			
General description	We will study the methods of Lagrangian and Hamiltonian Analytical Mechanics, and apply them in particular to the orbital mechanics of space vehicles. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

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.
B6	Capability to participate in flight testing programs for take-off and landing distances, ascent speeds, loss speeds, maneuverability and landing capacities.
C24	Appropriate knowledge applied to engineering: systems of aircrafts and automatic systems of flight control of the aerospace vehicles.
C26	Applied knowledge of aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed and rotary wings), theory of structures.
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

Learning outcomes	
Expected results from this subject	Training and Learning Results

Knowledge, understanding, application, analysis and synthesis of methods and techniques of Analytical Mechanics; specifically, of Lagrange and Hamilton-Jacobi equations, canonical transformations, and equilibrium, stability and oscillations of dynamical systems with N degrees of freedom.	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Knowledge, understanding, application, analysis and synthesis of the problems astrodinámicos related with the movement of the centre of masses of a spatial vehicle; in concrete, the orbits keplerianas, the real orbits conditioned by the different perturbacións orbitales, the orbits osculatrices and the numerical methods usual in Astrodinámica	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Knowledge and understanding of the dynamics of attitude of the space vehicles	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Contents	
Topic	
Analytical Mechanics	Introduction to Lagrangian Mechanics
	Introduction to Hamiltonian Mechanics
	Dynamical systems: examples; linearisation; Lyapunov stability; numerical integration
Orbital Mechanics	Kepler Movement
	Perturbative Forces: modeling; numerical methods for orbit determination and orbital elements computations
	Attitude Dynamics

Planning			
	Class hours	Hours outside the classroom	Total hours
Problem solving	12	18	30
Practices through ICT	12	18	30
Lecturing	26	39	65
Essay questions exam	2.5	0	2.5
Report of practices, practicum and external practices	0	22.5	22.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Problem solving	Solution of problems with the active participation of the students
Practices through ICT	The teacher will explain the theory
Lecturing	El docente expondrá la teoría en lecciones magistrales

Personalized assistance	
Methodologies	**Description**
Problem solving	The student will participate in the process of solving problems under the supervision of the teacher.
Practices through ICT	The student will take part in the resolution of numerical problems with the help of the teacher
Tests	**Description**
Report of practices, practicum and external practices	The student will take part in the elaboration of the practice reports of the practices with the help of the teacher

Assessment		
Description	Qualification	Training and Learning Results

Problem solving	Assistance and active participation in the classes of problem solving	5	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Practices through ICT	Assistance and active participation in the computer practices	5	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Essay questions exam	Exam	70	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Report of practices, practicum and external practices	Elaboration of a report describing the methodology and the results of the computer practices	20	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Other comments on the Evaluation

The students not following the continuous assessment will be evaluated only through the exam (100% in this case).

In second edition, there will be the opportunity to be evaluated only through the exam (100%) for the students who ask for it.
The dates of the final exams are published on the website of the EEAE in the web page http://aero.uvigo.es/gl/docencia/exames.

Sources of information

Basic Bibliography

H. Schaub, J. L. Junkins, **Analytical Mechanics of Space Systems**, AIAA Education Series, 2009

Howard Curtis, **Orbital Mechanics for Engeneering Students 3rd Edition**, 3ª, Elsevier, 2014

Oliver Montenbruck; Eberhard Gill, **Satellite Orbits: Models, Methods and Applications**, Springer; HAR/CDR edition (September 2, 2011), 2011

J. E. Prussing, B. A. Conway, **Orbital Mechanics**, 2ª, Oxford University Press, 2012

A. E. Roy, **Orbital Motion, Fourth Edition**, 4ª, CRC Press,

William T. Thomson, **Introduction to Space Dynamics**, Dover Publications, 1985

D. A. Vallado, **Fundamentals of Astrodynamics and Applications**, Springer, 2007

Complementary Bibliography

D. Tommasini, **Apuntes de la asignatura**,

R.R. Bate, D.D. Mueller, J.E. White, **Fundamentals of Astrodynamics (Dover Books on Aeronautical Engineering) Revised ed. Edition**,

P.C. Hughes, **Spacecraft Attitude Dynamics**, Dover Publications, 2004

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics I/O07G410V01103
Computer science/O07G410V01104
Mathematics: Linear algebra/O07G410V01102
Mathematics: Calculus I/O07G410V01101
Mathematics: Calculus II/O07G410V01201
Mathematics: Mathematical methods/O07G410V01301
Classical mechanics/O07G410V01305
Numerical calculation/O07G410V01941

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained
In the event that they cannot be given face-to-face, the master classes and problem solving classes will be taught by "Campus remoto" or by Microsoft Teams. These means, along with email, will also be used for interaction with students for the numerical practice exercises.

* Teaching methodologies modified
See above.

* Non-attendance mechanisms for student attention (tutoring)
The tutorials, in the case that they have to be non-face-to-face, will be held by email, by "Campus Remoto", or by Microsoft Teams, subject to prior agreement with the students.
* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests that are maintained
The continuous evaluation of the active participation in the classes and in the practices [total weight 10%] and of the memories of numerical practices [total weight 20%] will be maintained.

* Tests that are modified
In the case of not being allowed to do it face-to-face, the written exam will be done by email in a limited time (each student will have a different text) and will weigh 30%
* New tests
In the case of not being allowed to have face-to-face written exams, there will be an oral exam that will consist of two parts:
1. Individual oral presentation by videoconference of the report of the numerical calculation practices [weight 10%];
2. Individual presentation in videoconference with support in powerpoint, pdf, or another similar method of an individual work on an aspect of Orbital Mechanics (with the possibility of questions) [weight 30%]