# Universida<sub>de</sub>Vigo

Subject Guide 2023 / 2024

IDENTIFYIN	G DATA		1	777777777
Analytic an	d 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	#EnglishFriendly			
language	Spanish			
Department				
Coordinator	Tommasini , Daniele			
Lecturers	Tommasini , Daniele			
E-mail	daniele@uvigo.es			
Web	http://http://aero.uvigo.es/			
General	We will study the methods of Lagrangian and Ha	miltonian Analytical N	Mechanics, and a	apply them in particular
description	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.			

## 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.
- 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

#### Expected results from this subject

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 and understanding of the dynamics of attitude of the space vehicles	A2	B6	C24	D3
	A3		C26	D4
	A5		C33	D5
				D6
				D8
				D11
Knowledge, understanding, application, analysis and synthesis of the problems of astrodynamics	A2	B6	C24	D3
related with the movement of the centre of masses of a spacecraft; namely, the Keplerian orbits,	A3		C26	D4
and the real orbits as conditioned by the different perturbations, the osculating orbits and the	A5		C33	D5
usual numerical methods in astrodynamics.				D6
				D8
				D11

Contents	
Торіс	
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	1.25	0	1.25
Report of practices, practicum and extern	al practices 0	22.5	22.5
Essay questions exam	1.25	0	1.25
*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

Description
The student will participate in the process of solving problems under the supervision of the teacher.
The student will take part in the resolution of numerical problems with the help of the teacher
Description
The student will take part in the elaboration of the practice reports of the practices with the help of the teacher

## Assessment

Description

Training and Learning Results Qualification

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	First partial essay question exam	30	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	30	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Essay questions exam	Second partial essay question exam	30	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

## Other comments on the Evaluation

The evaluations of the continuous assessment will be realized during the classes.

In the continuous assessment, the practices and the proofs are mandatory and liberatory. While the practices are not recoverable, the students that do not have been able to realize the first partial essay question exam-or have not passed it-will be allowed to repeat it in the day of the final examination, in which the second partial essay question exam will also be done.

The student has the right to opt for the exam-only assessment according to the procedure and the deadline established by the centre for each call. In this case, the student will be evaluated only through the exam (100% in this case).

All these criteria apply to both the first and the second call.

In the end-of-program call, the student will be evaluated only through the exam (100% in this case).

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.

The dates of the first partial essay question exam will be communicated at the beginning of course.

Sources of information
Basic Bibliography
Howard Curtis, Orbital Mechanics for Engeneering Students 3rd Edition, 3 <sup>a</sup> , Elsevier, 2014
H. Schaub, J. L. Junkins, Analytical Mechanics of Space Systems, AIAA Education Series, 2009
Oliver Montenbruck; Eberhard Gill, Satellite Orbits: Models, Methods and Applications, Springer; HAR/CDR edition (September 2, 2011), 2011
J. E. Prussing, B. A. Conway, <b>Orbital Mechanics</b> , 2 <sup>a</sup> , Oxford University Press, 2012
A. E. Roy, <b>Orbital Motion, Fourth Edition</b> , 4 <sup>a</sup> , 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, <b>Apuntes de la asignatura</b> ,
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/007G410V01103 Computer science/007G410V01104 Mathematics: Linear algebra/007G410V01102 Mathematics: Calculus I/007G410V01101 Mathematics: Calculus II/007G410V01201 Mathematics: Mathematical methods/007G410V01301 Classical mechanics/007G410V01305 Numerical calculation/007G410V01941