



## 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			
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Web	<a href="http://http://aero.uvigo.es/">http://http://aero.uvigo.es/</a>			
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.			

## 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 language
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
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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	B6	C24	D3
	A3		C26	D4
	A5		C33	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 related with the movement of the centre of masses of a spacecraft; namely, the Keplerian orbits, and the real orbits as conditioned by the different perturbations, the osculating orbits and the usual numerical methods in astrodynamics.	A2	B6	C24	D3
	A3		C26	D4
	A5		C33	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	1.25	0	1.25
Report of practices, practicum and external 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

## 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	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 Engineering 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, **Orbital Mechanics**, 2<sup>a</sup>, Oxford University Press, 2012

A. E. Roy, **Orbital Motion, Fourth Edition**, 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, **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

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## **Recommendations**

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### **Subjects that it is recommended to have taken before**

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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

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