

1. BASIC INFORMATION

Course	Flight Mechanics (Mecánica del Vuelo)		
Degree program	Aerospace Engineering		
School	Escuela de Ingeniería, Arquitectura y Diseño, UEM		
Year	3		
ECTS	6		
Credit type	Compulsory		
Language(s)	English		
Delivery mode	Face to face		
Semester	2nd		
Academic year	2022-2023		
Coordinating professor	Raul Llamas	raulcarlos.llamas@universidadeuropea.es	

2. PRESENTATION

Flight Mechanics is the area of the Physics of Flight devoted to the study and analysis of the stability, controllability and flight performance of aerospace vehicles. Aircraft are required to fly safely in all points of their flight domain and this requires that the pilot (or an automatic flight control system) may be able to control the trajectory and attitude of the aircraft using normal piloting skills and forces. Aircraft performance studies the power required to fly, fuel consumption, range, endurance and take-off and landing field lengths.

Flight Mechanics is one of the cornerstones of aerospace engineering as it integrates knowledge of aerodynamics, propulsion, aircraft systems and control theory to enable the calculation of aircraft handling qualities and performance. The safe flight of aircraft relies on adequate stability and control characteristics which need to be "designed" in the aircraft and substantiated by flight test. The economic and environmental impact of flight is minimised through the design of high performance aircraft and the calculation of important design parameters like fuel consumption and field length is also part of the subject of flight mechanics.

This subject is part of module "Aerospace Vehicles II" which includes the following subjects: 1- Aeronautical Structures and Vibrations, 2- Aerodynamics and Aeroelasticity, 3- Space Vehicles and Missiles, 4- Flight Mechanics, 5- Maintenance and Certification of Aerospace Vehicles, 6- Aircraft Design.



3. COMPETENCIES AND LEARNING OUTCOMES

The following table shows the relationship between the competencies developed during the course and the learning outcomes pursued:

Competencies	Learning outcomes		
Capacity for the design, development and management in the field of aeronautical engineering whose purpose, in accordance with the knowledge acquired as established in section 5 of Ministerial Order CIN / 308/2009, aerospace vehicles.CT1			
Planning, drafting, direction and management of projects, calculation and manufacturing in the field of aeronautical engineering whose purpose, in accordance with the knowledge acquired as established in section 5 of Ministerial Order CIN / 308/2009, vehicles aerospace.CT2	Carry out studies in which the technologies and engineering procedures related to the		
Deal with problems and challenges related to their field of knowledge with flexibility, initiative, innovation, and dynamism (Profile owner). CT17	competencies of this module come into play.		
Work in interdisciplinary teams, providing the greatest efficiency on the basis of cooperation, assuming their role within the team, establishing good relationships and exchanging information, and practicing the culture of peace and solidarity (Teamwork). CT19			
Adequate Engineering knowledge applied to: Aircraft systems and automatic flight control systems for aerospace vehicles. CE24			
Adequate and applied Engineering knowledge of: aeronautical design and project calculation methods; the use of aerodynamic experimentation and the most significant parameters in its theoretical application; handling of the experimental techniques, equipment and measuring instruments typical of the discipline; the simulation, design, analysis and interpretation of experimentation and operations in flight; aircraft maintenance and certification systems. CE25	From a series of requirements, and prior information, conceptualize an engineering problem, using the right approach to solving it, and develop the best solution. All of this using the competencies of this module.		
Applied knowledge of: aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed wing and rotary wings), structures theory. CE26			



4. CONTENT

UNIT 1: Revision of Aerodynamics

- Revision of airfoil, wing and aircraft aerodynamics (aerodynamic lift, drag and moments)

UNIT 2: Static stability and control

- Definition of stability and controllability
- Longitudinal aircraft static trim. Neutral point and static margin
- Propulsive and configuration effects
- Lateral-directional stability. Aircraft roll and dihedral effect
- Lateral control and manoeuvrability
- Description of the flight controls system
- Control forces. Actuation systems
- Flight control computers; fly-by-wire and augmented stability

UNIT 3: Dynamic stability and control. Handling Qualities

- Linearised equations of motion
- Longitudinal eigenmodes (short period and phugoid). Pitch control
- Lateral-directional eigenmodes (spiral mode, Dutch-Roll)
- Aircraft Handling Qualities (Harper-Cooper scale)

UNIT 4: Revision of Propulsion

- Revision of propulsive forces on propeller, turbofan and turbojet engines

UNIT 5: Aircraft performance

- Gliding flight and coordinated turn
- Available and required power for flight
- Computation of Range and endurance
- Calculation of take-off field length
- Calculation of time and fuel consumption in climb to ceiling

UNIT 6: Flight simulation

- Introduction to flight simulation
- Aircraft mathematical modeling
- Practical exercises with a flight simulator

5. TEACHING-LEARNING METHODOLOGIES

The types of teaching-learning methodologies that will be used are:

1. Survey of goals and interests of the students



- 2. Master classes
- 3. Laboratory practices
- 4. Design, research and problem solving as teamwork
- 5. Individual design assignments
- 6. Simulation
- 7. Case studies
- 8. Field experiences, conferences, visits to companies and institutions

6. LEARNING ACTIVITIES

The table below shows the types of training activities that will be performed and the expected hours of dedication of the student to each of them:

Training activity	Number of hours
1. Master Classes	60
2. Individual work	110
3. Tutoring, academic monitoring and evaluation	6

7. EVALUATION

The table below shows the performance evaluation methods, as well as their corresponding weight on the final grading of the subject:

Evaluation system	Weight
1. Exams, tests and other test of knowledge	30% min
2. Preparation of articles and reports	30% min
3. Alternative means of assessment (if applicable)	15% max
4. Field experiences, lectures, and visits (if applicable)	10% max
5. Transversal competences (rubrics) (if applicable)	10% max

In the Virtual Campus, when you access the course, you'll be able to consult in detail the assessment activities that you must perform, as well as the dates of delivery and the evaluation procedures of each of them.

7.1. First exam period (ordinary call)

To pass the subject in ordinary period you will need to obtain a mark higher than or equal to 5.0 out of 10.0 (5/10) in the final grade (weighted average) of the course.



In any case, you will need to obtain a mark higher or equal to 4.0 in the final examination in order that it can be averaged with the rest of the activities. Otherwise, the final course grade will be equal to the mark in the final exam.

The gradable items and technical skills being evaluated follow:

- Individual report on Aircraft Accident analysis.
 - Ability to integrate the knowledge acquired during the degree and the course in the analysis of the root causes related to Flight Mechanics of aircraft accidents.
 - Demonstrate competence in technical communication in written forms.
- Individual report on Aircraft Performance assessment of a large commercial aircraft.
 - Ability to obtain and evaluate technical information related to aircraft performance characteristics.
 - Technical competence in the calculation of aircraft performance and its reporting.
- Individual report on basic Aircraft Design and Aircraft Stability analysis.
 - Ability to design a simple aircraft using basic requirements
 - Understanding of the aerodynamic and stability parameters required to guarantee trimmability and stability while preserving the performance of the aircraft
 - Competence in technical writing and reporting of a complex topic, showing ability to describe the design process, technical data generated and reference appropriately.
- Individual report on wing optimization and performance analysis of a small aircraft.
 - Understand the wing planform optimization process to achieve maximum performance
 - Show technical capacity to assess the performance effect of a major modification of the aircraft
 - Technical ability to develop computer code to calculate basic performance characteristics

Final examination. To evaluate the student's technical skills specific to the design of aircraft. The content to be evaluated will be clearly identified during the classes and in the teaching materials.

Full list of assessment activities in the ordinary call and their weights in the final grade:

- Report on Aircraft Accident analysis 20%
- Report on Aircraft Performance assessment of a large commercial aircraft. 20%
- Report on basic Aircraft Design and Aircraft Stability analysis 10%
- Report on wing optimization and performance analysis of a small aircraft 20%
- Final written examination (open book in ordinary call): 30 % of the grade

Minimum marks required to pass in ordinary call:

- 4/10 in the written final examination.
- 4/10 in each of the individual assessments.
- All the assignments corresponding to the ordinary call delivered and uploaded in time. Assessments delivered late will be marked with a 4 or the actual grade if lower than 4.
- 50% class attendance

General considerations on the course assessment:

- The final grade is a weighted average of the assessments of all the activities undertaken during the course, with the following weights in ordinary call:
 - The evaluation of the activities of continuous assessment represents the 70% of the final grade of the subject.
 - Final examination: 30% of the final grade of the subject.



• To be graded the student must show a 50 % class attendance. Students who do not attend at least 50% of the classes will automatically fail in ordinary call and must recover the course in the extraordinary call. Students who, for justified reasons, cannot attend 50% of classes must obtain an authorization from their tutors and communicate in advance their situation to the lecturer.

The students who for justified reasons are unable to deliver assignments or sit examinations in time must obtain an authorization from their tutor and communicate immediately their situation to the lecturer who will then set a date and time for the student to recover the activities.

7.2. Second exam period (extraordinary call)

To pass the subject in extraordinary call the students must obtain a mark higher or equal to 5/10 in the final grading (as a weighted average) of the course.

In any case, the students must obtain a mark higher or equal to 4/10 in the extraordinary examination and specific extraordinary assignment so that they can be averaged with the rest of the activities.

The students must upload all the assignments not delivered in ordinary period in order to be graded in the extraordinary call.

The content of the specific extraordinary assignment will be published two days after the publication of the final grades in ordinary call. In general, the assignment will cover all the topics of the course and therefore will be a substantial piece of work.

Evaluation activities in extraordinary call:

- Individual specific project: 50 % (there will be a test of authorship for the assessment of individual students)
- Written final examination (closed book): 50 % of the grade. There will be no access to any kind of documentation, online sources or class notes in this test.

Minimum requirements to pass in extraordinary call:

- 4/10 in the extraordinary written examination.
- 4/10 in the individual assessment of the project.
- 5/10 overall
- All the assignments corresponding to the ordinary call uploaded.



8. SCHEDULE

This table shows the delivery deadline for each assessable activity in the course:

	Assessable activities	Deadline
•	Report on Aircraft Accident analysis	Check Canvas
•	Report on Aircraft Performance assessment of a large commercial aircraft. 20%	Check Canvas
•	Report on basic Aircraft Design and Aircraft Stability analysis 10%	Check Canvas
•	Report on wing optimization and performance analysis of a small aircraft 20%	Check Canvas
Written test final integrative		Check Canvas

This schedule may be subject to changes for logistical reasons relating to the activities. The student will be notified of any change as and when appropriate.

9. **BIBLIOGRAPHY**

The basic reference textbook is:

PHILLIPS, W, *Mechanics of Flight*, Wiley. 2nd ed. 2009, ISBN-10: 0470539755

Additional references will be given during the course and will include other relevant textbooks, research papers and general literature (e.g. current events, accident reports, etc...)

10. DIVERSITY MANAGEMENT UNIT

Students with specific learning support needs:

Curricular adaptations and adjustments for students with specific learning support needs, in order to guarantee equal opportunities, will be overseen by the Diversity Management Unit (UAD: Unidad de Atención a la Diversidad).

It is compulsory for this Unit to issue a curricular adaptation/adjustment report, and therefore students with specific learning support needs should contact the Unit at <u>unidad.diversidad@universidadeuropea.es</u> at the beginning of each semester.



11. SATISFACTION SURVEYS

Your opinion matters!

The European University encourages you to participate in satisfaction surveys to detect strengths and areas for improvement on the faculty, the degree and the process of teaching-learning.

The surveys will be available in the space of surveys of your virtual campus or through your email.

Your assessment is needed to improve the quality of the degree.

Many thanks for your participation.

12. CODE OF ETHICS

Each student must abide by the code of ethics of the School of Architecture, Engineering and Design of the European University of Madrid.

Every student must obey the rules of the School and behave respectfully towards the lecturers and fellow classmates.

The lecturer is authorized to expel any student from class when he / she is disturbing the good order of the session.

Students who commit a serious disciplinary offense will be subject to disciplinary procedure of the University.

In particular, students found copying or committing plagiarism or fraud will automatically fail the subject in that call with a grade of 0. In addition, in these cases, the University may open a disciplinary dossier as per the European University internal regulations and the legislation of the Spanish Ministry of Universities.

HOW TO COMMUNICATE WITH YOUR LECTURER

Whenever you have a question about the content or activities, don't forget to post it to your course forum so that your classmates can read it.

You might not be the only one with the same question!

If you have a question that you only want to ask your professor, you can send him/her a private message from the Campus Virtual. And if you need to discuss something in more detail, you can arrange an advisory session with your professor.

It's a good idea to check the course forum on a regular basis and read the messages posted by your classmates and professors, as this can be another way to learn.

DESCRIPTION OF ASSESSMENT ACTIVITIES

In Canvas



RUBRICS OF ASSESSMENT ACTIVITIES

		0 - Not compliant	1- Below expectations	2 - Just acceptable	3- As expected	4 - Excellent
A	The report is legible and properly formatted	handwritten report, pictures taken carelessly from a phone camera, untidy format	Spelling mistakes (the spell checker has obviously not been used)	No spelling mistakes and all sections covered	Correct format (including cover page) and good readability	Impeccable format and excellent readability
в	The report is written in technical style	The student uses a personal style; e.g. "I have written this report", "I did my calculations", "As we saw in class"	Common or non-technical words are used instead of the correct terms; e.g. motor instead of engine	Impersonal style; "This report presents the calculations carried out in order to estimate the"	Correct impersonal style, corect use of technical terms, references included and pictures labelled	Impeccable text, technical drawings, all referenced and relevant
с	There is enough background information presented	No sources are cited. No explanation of what assumptions are taken	Poor referencing and explanation of assumptions	There are references and minimal explanations of assumptions	All data used is referenced, sources are identified and the assumptions are clearly explained	The technnical data used is relevant and properly classified, referenced and used. Assumptions are well explained and related to the theory
D	The calculations are correct and well justified	No calculations in the document, just results	Only formulas are written and results, no development of the calculations	The calculations are explained but the results are wrong	Concise and relevant calculations are presented and the results are correct	All results are correct and the calculations are relevant and easy to follow
E	Conclusions	No conclusions	Conclusions are irrelevant, not related to the objectives of the exercise; e.g. "I learnt a lot doing this"	The conclusions provide value regarding the calculations performed: results are interpreted and can be used to infer actions	Detailed conclusions on each of the major calculations. Relevant lessons learnt are drawn which can be used to inform decisions	Extensive conclusions related to the calculations and the underlaying theory. Significant value and insight provided which can be used to drive further research and make important decisions
F	References	No references	List of references at the end of the text but no indication of when they are used within the report	List of references and indication in the main text of their use. Mainly from internet sources (e.g. forums)	Relevant list of references (not just wikipedia or forums) and correct quoting	Extensive and relevant list of references including academic and industrial sources. All quotes referenced properly in the text and the figures