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**Academic Year: ( 2023 / 2024 )****Review date: 29-03-2023**

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**Department assigned to the subject: Aerospace Engineering Department****Coordinating teacher: MERINO MARTINEZ, MARIO****Type: Compulsory ECTS Credits : 6.0****Year : 2 Semester : 1**

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**REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)**

Calculus I, Calculus II, Linear Algebra, Physics I.

We strongly advise you against taking this course if you have not passed Physics I yet.

**OBJECTIVES**

The goal of this course is that the student acquires a basic knowledge of classical mechanics applied to flight mechanics and aerospace systems.

**DESCRIPTION OF CONTENTS: PROGRAMME**

## 0 Introduction

- Newton's laws
- Scalar and vector quantities
- Review of vector calculus
- Degrees of freedom and constraints

## 1 Kinematics of point particles

- Reference frames
- Position, velocity and acceleration
- Planar motion
- Tangential and normal components
- Relative motion
- Rotations
- Relations between position, velocity and acceleration using translating and rotating axes

## 2 Dynamics of point particles

- Force and momentum
- Work and energy
- Rectilinear motion. Vibrations.
- Motion of a free particle
- Motion of a particle over a curve
- Motion of a particle over a surface
- Relative dynamics
- Angular momentum
- Central forces
- Kepler's problem
- Elliptical trajectories

## 3 Kinematics of a rigid body

- Velocity and acceleration fields
- Properties of the velocity field
- The Euler angles

## 4 Geometry of masses

- Center of mass
- Moments of inertia
- Moment of inertia tensor
- Steiner's theorem

- Principal axes

#### 5 Rigid body dynamics

- Linear momentum
- Angular momentum
- Kinetic energy
- General equations for a system of particles
- General equations for the rigid body
- Equilibrium
- Work and energy principles

#### 6 Systems of rigid bodies

- General equations
- Constraints and linkages

#### 7. Torque-free motion of the rigid body

- Kinematics
- Dynamics and conservation laws
- Polhode and herpolode. Stability

#### 8 The airplane as a point particle

- Airplane parts
- Forces on the airplane: Lift, drag, aerodynamic moments
- Straight and level flight
- Gliding flight
- Climbing flight

### LEARNING ACTIVITIES AND METHODOLOGY

Theory sessions in master classes (flipped classroom methodology will be followed)

Problem sessions in reduced groups

Lab-sessions and computer sessions with mathematical software

Personal and group work

### ASSESSMENT SYSTEM

End-of-term exam (60%)

Class quizzes (20%)

Lab sessions (20%)

In order to pass the subject, two requirements need to be met:

1) to have a MINIMUM mark of 4.0/10 in each part of the end-of-term exam;

2) to have a minimum overall mark of 5.0/10 (weighing 60% the end-of-term exam mark and 40% the mark of the continuous evaluation).

**% end-of-term-examination:** 60

**% of continuous assessment (assignments, laboratory, practicals...):** 40

### BASIC BIBLIOGRAPHY

- J. H. Ginsberg Engineering Dynamics, Cambridge Univ. Press, 2007

### ADDITIONAL BIBLIOGRAPHY

- A.C. Kermode Mechanics of Flight, Pearson, 2012

### BASIC ELECTRONIC RESOURCES

- Mario Merino . ANAKIN code: <https://github.com/uc3m-aerospace/anakin>