# Mechanics applied to Aerospace Engineering

**Academic Year: ( 2021 / 2022 )** **Review date: 04-06-2021**

**Department assigned to the subject: Bioengineering and Aeroespace Engineering Department**

**Coordinating teacher: MERINO MARTINEZ, MARIO**

**Type: Compulsory ECTS Credits : 6.0**

**Year : 2 Semester : 1**

## 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-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

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 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).

## 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