

Academic Year: ( 2022 / 2023 )

Review date: 05-04-2022

Department assigned to the subject: Aerospace Engineering Department

Coordinating teacher: MERINO MARTINEZ, MARIO

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 2

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

Calculus I, Linear Algebra, Physics I, Programming, Calculus II, Mechanics Applied to Aerospace Engineering, Advanced Mathematics, Modeling in Aerospace Engineering, Mechanics of Flight I.

**OBJECTIVES**

Formulate and solve orbital mechanics problems, use that knowledge to perform preliminary designs of space missions, and evaluate the capabilities of different spacecraft and space systems.

**DESCRIPTION OF CONTENTS: PROGRAMME**

1. Two body problem
  - Conservation laws
  - Conics and orbital elements
2. Kepler's equation
  - Formulation for the elliptic, parabolic, hyperbolic cases
  - Numerical solution
3. Orbital maneuvers
  - Fundamentals of spherical trigonometry
  - Hohmann, bielliptic transfers; plane change; phasing maneuvers, electric orbit raising
4. Preliminary orbit determination
  - Gibbs problem, Gauss problem
  - Lambert's problem
  - Porkchop diagrams
5. Perturbations
  - Special perturbation methods
  - General perturbation methods
  - Drag, solar radiation, third body
  - Geopotential and spherical harmonics
6. Interplanetary trajectories
  - Patched-conics method
  - Launch and B-Plane targeting
7. Relative motion and rendezvous
  - Clohessy-Wiltshire equations
8. Circular restricted three body problem
  - Derivation and normalization. Jacobi's energy integral
  - Lagrange libration points
  - Stability and trajectories near Lagrange points
9. Space vehicles: attitude dynamics
  - Free body attitude kinematics and dynamics
  - Gravity gradient
  - Reaction control system and reaction wheels
10. Introduction to space missions and space systems
  - Application orbits, types of missions
  - Spacecraft subsystems

**LEARNING ACTIVITIES AND METHODOLOGY**

Theory sessions in master classes (flipped-classroom methodology)  
Problem sessions in reduced groups  
Computer sessions with mathematical software  
Personal and group work

## ASSESSMENT SYSTEM

End-of-term exam (60%)  
Continuous evaluation (40%)

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).

<b>% end-of-term-examination:</b>	60
<b>% of continuous assessment (assignments, laboratory, practicals...):</b>	40

## BASIC BIBLIOGRAPHY

- Hanspeter Schaub and John L. Junkins Analytical mechanics of space systems, AIAA, 2003
- Howard D. Curtis Orbital Mechanics for Engineering Students, Elsevier, 2010

## ADDITIONAL BIBLIOGRAPHY

- Peter Fortescue, Graham Swinerd, John Stark Spacecraft systems engineering, John Wiley and Sons, 2011