

Academic Year: (2024 / 2025)

Review date: 12-03-2024

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

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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-examination:	60
% of continuous assessment (assignments, laboratory, practicals...):	40
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).

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