Astrodynamics and atmospheric flight dynamics

Academic Year: (2018 / 2019) **Review date: 10-05-2018**

Department assigned to the subject: Department of Bioengineering and Aerospace Engineering

Coordinating teacher: SANJURJO RIVO, MANUEL

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

OBJECTIVES

COMPETENCES

Knowledge and understanding to provide a basis or opportunity for originality in developing and / or applying ideas, often within a research context

Students should be able to apply their knowledge and ability to solve problems in new or unfamiliar environments within broader contexts (or multidisciplinary) contexts related to their field of study

Students should be able to integrate knowledge and handle complexity, and formulate judgments based on information that was incomplete or limited, include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments

Students can communicate their conclusions and the knowledge and rationale underpinning to specialists and non-specialists in a clear and unambiguous way.

Students should adquire the learning skills to allow them to continue studying in a self-directed or autonomous way.

Ability to analyze and solve aerospace problems in new or unfamiliar environments within broader and complex contexts

Understanding and mastery of the Atmospheric Flight Mechanics (Performances and Static and Dynamic Stability and Control) , and Orbital Mechanics and Attitude Dynamics .

SKILLS

The student should be able at the end of the course to:
Solve celestial mechanics and orbit determination problems
Pose and design a space mission using navigation algorithms
Analyze the stability and control of aerospace vehicle in atmospheric flight

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
2.- Two Body Problem
    2.1. 2B equation
        Conservation of angular momentum, eccentricity and mechanical energy
    2.2. Kepler Equation. Methods of solution
    2.3. Satellite State Representation
3.- Three Body problem
    3.1. Equations of motion
    3.2. Lagrange's Solution
    3.3. Restricted 3BP.
4.- N-Body problem
5.- Central Body Gravity Field
    5.1. Spherical Harmonics
    5.2. Other representations
6.- Special Perturbation Techniques
    6.1. Encke's and Cowell's Formulations
    6.2. Numerical Integration Methods

6.3. Disturbing forces: Third body/Solar Radiation Pressure/...

7.- General Perturbation Techniques

7.1. Variation of parameters.

7.2. Perturbing Force Effects on Satellites.

8.- Orbital Maneuvering

8.1. Co-planar Maneuvers

8.2. Non co-planar transfer

8.3. Circular Rendez-vouz

8.4. Relative Motion

8.5. Continuous-Thrust

8.6. Optimal Control Problem

9.- Preliminary Orbit Determination

9.1. Lambert's Problem.

9.2. Observations.

10.- Orbit Determination and Estimation.

10.1. Linear Least Squares

10.2. Non Linear Least Square

10.3. Kalman Filtering

11.- Atmospheric Trajectories

11.1. Airplane Flight Paths (Cruise, Take-off, climb)

12.- Attitude Dynamics of Aircraft

12.1. Stability Derivatives

12.2. Longitudinal Dynamics

12.3. Lateral Dynamics

11.4. Inertia Coupling

LEARNING ACTIVITIES AND METHODOLOGY

LEARNING ACTIVITIES

Lessons
Exercises
Laboratory sessions in computer rooms.
Student individual work

Methodology

Presentations in class with teacher support and audiovisual media, in which the main concepts of the subject are developed and the literature is provided to supplement student learning.

Critical reading recommended by the subject teacher texts: reports, manuals, and / or scholarly articles, either for subsequent class discussion, either to expand and consolidate the knowledge of the subject.

Solving practical cases, problems, etc.. posed by the teacher individually or in group

Preparation of papers and reports individually or in group

ASSESSMENT SYSTEM

There are a modular assignment through the semester. The overall assignment represents 75% of the total grade. Final exams correspond to the remaining 25%. Required minimum mark on final exam: 4/10

% end-of-term-examination:	25
% of continuous assessment (assigments, laboratory, practicals…):	75

BASIC BIBLIOGRAPHY

- Ashish Tewari Atmospheric and Space Flight Dynamics, Birkhäuser, 2007
- David A. Vallado Fundamentals of Astrodynamics and Applications. 3rd edition, Space Technology Library, 2007

ADDITIONAL BIBLIOGRAPHY

- H. Schaub, J. Junkins Analytical Mechanics of Space Systems, AIAA; 2 edition , October 1, 2009
- Conway Spacecraft Trajectory Optimization, Cambridge University Press; 1 edition, 2014
- Howard Curtis Orbital Mechanics for Engineering Students, Butterworth-Heinemann; 3 edition , November 8, 2013