Course guide
205224 - RESS - Robotic Exploration of the Solar System

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Manel Soria

Others: Manel Soria
Arnau Miró

PRIOR SKILLS

General concepts of aerospace vehicles. Programming skills in any computer language (preferably, Matlab). Deep interest for space engineering.
It is advisable to have taken the course 220013 Vehicles Aeroespacials.

TEACHING METHODOLOGY

The course will be developed through theoretical lectures and hands-on sessions where the students will study previous robotic probes and their scientific results. In many cases, the students will need to develop small computer codes to process the large amounts of data available. Where possible, the original data such as RAW images or SPICE kernels will be used for the class examples, as well as the original journal papers.

LEARNING OBJECTIVES OF THE SUBJECT

-Have a basic knowledge of the main solar system bodies and the main present, projected and previous exploration probes such as Voyager or Cassini.
-Understand at an introductory level the main space engineering concepts involved in the design of the probes, such as attitude control system, electric power or propulsion.
-Understand the main remote sensig instruments and techniques such as multispectral cameras or radio occultation at an introductory level.
-Understand at an introductory level the digital image formats and main processing algorithms such as contrast adjustment or registration.
-Understand at an introductory level the NASA SPICE library (goal, main functions, kernels, etc) and be able to use it to calculate the position, velocity, camera orientation etc of different spacecraft.
-Be able to combine SPICE kernels with RAW images information to produce relevant information of celestial bodies (such as, for instance, volcanic eruptions in Io).

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	40.00
Self study	45,0	60.00

Total learning time: 75 h

CONTENTS

Module 1: Introduction to the Solar System and its exploration

Description:
Solar system bodies (planets, asteroids, comets, Kuiper belt objects). Robotic probes and their missions: Flyby encouters, orbiters, landers, rovers, drones.

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

Module II. Introduction to imaging instruments and image processing technology

Description:
Lenses. Image sensors. Monochrome, color and multispectral images. Introduction to image processing algorithms.

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

Module III. Introduction to NASA JPL SPICE library

Description:
SPICE overview. Functions and kernels. MICE (SPICE for Matlab). Frames. Time. Obtaining spacecraft position and velocity. Time windows. Occultations. Camera kernels and application examples.

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

GRADING SYSTEM

Class participation and class exercices: 30%
Assignment: 30%
Project: 40%
Students with a grade below 5.0 in the project, or the assignments, or the classroom participation, will be able to take an additional written exam covering all the subject, that will take place in the date fixed in the calendar of final exams. The grade obtained in this exam will range between 0 and 10, and will replace the part or parts below 5.0 only in case it is higher, up to a maximum of 5.0 points.

BIBLIOGRAPHY

Basic:

- Ulivi, Paolo; Harland, David M. Robotic exploration of the Solar System. Part 4, The Modern Era 2004 –2013 [on line]. New York: Springer, 2015 [Consultation: 03/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1967801. ISBN 9781461448129.
- Ulivi, Paolo; Harland, David M. Robotic exploration of the Solar System. Part 2, hiatus and renewal, 1983-1996 [on line]. New York: Springer Praxis Books, 2009 [Consultation: 03/05/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-78905-7. ISBN 9780387789040.
- Ulivi, Paolo ; Harland, David M. Robotic exploration of the Solar System. Part 1, The Golden Age 1957-1982 [on line]. Chichester, UK: Springer : Praxis Publishing, 2007 [Consultation: 25/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=336714. ISBN 9780387493268.
- Ulivi, Paolo; Harland, David M. Robotic exploration of the Solar System. Part 3, The Modern era 1997-2009 [on line]. New York: Springer, 2012 [Consultation: 03/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1106125. ISBN 9780387096285.

Complementary:

- Manning, R. [et al.]. Mars rover curiosity: an inside account from Curiosity's chief engineer [on line]. Washington, D.C: Smithsonian Books, 2014 [Consultation: 03/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6091578. ISBN 9781588344748.
- Stern, Alan. Chasing new horizons: inside the epic first mission to pluto. Picador, 2018. ISBN 9781250098962.