Space systems design

Academic Year: (2019 / 2020) **Review date: 29-04-2020**

Department assigned to the subject: Bioengineering and Aeroespace Engineering Department

Coordinating teacher: CICHOCKI , FILIPPO

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- BSc Aerospace Engineering courses related to: Classical mechanics, electromagnetism, thermodynamics, heat transfer, electric power, structural calculus, rocket motors, control theory, computer programming
- Astrodynamics and Atmospheric Flight Dynamics

OBJECTIVES

At the end of the course, the student shall be capable of understanding and mastering:

- The design and analysis of space systems and space missions
- The unique aspects of the space environment and the requirements it imposes on a Space System / Space Mission
- The types of Space system, Space Mission phases and procedures, and the design drivers behind each of them
- The different segments that compose a space system
- The different subsystems of the space segment in a space mission, their operation and sizing
- The space propulsion systems, launchers, and their operation
- Ground segment requirements and operation
- The certification requirements for space vehicles, and judge their acceptance levels

DESCRIPTION OF CONTENTS: PROGRAMME

- Introduction to Space Systems, Space Missions and segments (space, ground and launch)
- The space environment
- Space Systems Engineering
- Mission analysis, fundamentals of orbital mechanics, orbital maneuvers, groundtracks, mission examples in LEO, MEO, GEO and interplanetary missions
- The space segment subsystems:
  - o Space propulsion
  - o Communications
  - o Electric power
  - o On board computer
  - o Telemetry, tracking and telecommand
  - o Structures and mechanisms. S/C configuration
  - o ADCS and translational GNC
  - o Thermal control
- GNSS systems
- Launchers and access to space
- Manufacturing, assembly; certification, testing and QA
- Ground segment and operations
- End of life considerations; space debris, space law

LEARNING ACTIVITIES AND METHODOLOGY

The course has 29 classroom sessions (100 minutes) will be divided as follows:

- theory and design example sessions / problem solving sessions (24 sessions)
- Computer sessions (3 sessions)
- Student project final presentation session (1 session)
- Visit to ESAC center (1 session, to be confirmed every year)

An important part of the continuous evaluation is a space mission design project to be carried out in groups, for which students shall use the softwares learnt at the computer sessions. Several collective tutorial sessions will be planned along the course to guide the design project.

A visit to ESA ESAC facilities in Villanueva de la Cañada will take place during the course (to be confirmed each year). Invited talks by ESA experts and others will be organized (to be confirmed each year).

An important part of the course is the individual and team student work outside of classroom hours. Along the course, several voluntary homeworks will be handed out for student practice. The course has an estimated student workload of 150 h (6 ECTS), including personal work.

Communication with the students will be done through aulaglobal: aulaglobal.uc3m.es. Students can ask for tutorial sessions with the faculty on the hours advertised there.

ASSESSMENT SYSTEM

In order to pass the subject, two requirements need to be met:

1) To have a MINIMUM grade of 4.0/10 in the end-of-term exam.
2) To have a MINIMUM overall grade of 5.0/10 (weighting 60% the end-of-term exam grade and 40% the continuous evaluation grade).

Continuous evaluation (40%) includes:
- Group Design Project
- Quiz during the course

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- P. Fortescue Spacecraft systems engineering, Wiley, 2011

ADDITIONAL BIBLIOGRAPHY

- D.A. Vallado Fundamentals of Astrodynamics and Applications, Microcosm Press, 2013
- G.P. Sutton Rocket Propulsion Elements, Wiley, 2010
- M.D Griffin Space Vehicle Design, AIAA Education Series, 2004
- P. Fortescue Spacecraft systems engineering, Wiley, 2011
- V.L. Pisacane The Space Environment and Its Effects on Space Systems, AIAA Education Series, 2008
- V.L. Pisacane Fundamentals of Space Systems, Oxford University Press, 2005
- Wertz/Everett/Puschell Space Mission Engineering, The New SMAD, Microcosm Press, 2011