Power Subsystem

Academic Year: (2020 / 2021) **Review date: 12-07-2020**

Department assigned to the subject:

Coordinating teacher: BARRADO BAUTISTA, ANDRES

Type: Compulsory ECTS Credits : 2.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

An introductory course on Power Electronics
Electric circuit analysis
Control theory

OBJECTIVES

Basic competences

CB6 To possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context
CB7 Students must know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study
CB8 Students must be able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments
CB9 Students must know how to communicate their conclusions and the knowledge and ultimate reasons that sustain them to specialized and non-specialized audiences in a clear and unambiguous way
CB10 Students must have the learning skills allowing them to continue studying in a way that will be largely self-directed or autonomous.

General competences

CG1 Capacity for the formulation, critical verification and defense of hypotheses, as well as the design of experimental tests for verification.
CG2 Ability to make value judgments and prioritize in making conflicting decisions using systemic thinking.
CG4 Ability to work in multidisciplinary teams in a cooperative way to complete work tasks
CG5 Ability to handle the English, technical and colloquial language.

Specific competences

CE6 Ability to understand and apply the knowledge, methods and tools of space engineering to the analysis of the power systems of space vehicles.

LEARNING RESULT
Electrical power subsystem (EPS) course addresses the production, storage, conversion, distribution and management of the electrical power in a space vehicle. This course tackles from the requirements to the design process. The main basic components of the spacecraft power subsystem are studied, such as primary power sources, including Fuel Cell, Solar PV, Static and Dynamic power; energy storage, studying several types of batteries; power distribution based on power converters, MPPT, relays and protection; and finally the power management.
In addition, during the course several design examples are developed such us EPS architecture selection, power balance, solar panel sizing and battery sizing.
Thanks to this course, the student will be able to get a general knowledge about the power distribution system of current spacecraft.

DESCRIPTION OF CONTENTS: PROGRAMME

The program of the subject includes:

1. Electrical Power Subsystem Overview
   1.1. Introduction
   1.2. Power system functions
   1.3. Architecture and components identification
   1.4. Design process
2. Primary power sources
   2.1. Types of Primary Sources
      2.1.1. Primary batteries
      2.1.2. Fuel Cell
      2.1.3. Solar photovoltaic
      2.1.4. Static Power - RTG
      2.1.5. Dynamic Power
   2.2. Comparative
   2.3. Sizing the Solar Panels
3. Energy Storage
   3.1. Introduction to batteries
   3.2. Primary and secondary batteries: types of batteries
   3.3. The battery in the Photovoltaic¿Battery System: operating modes
   3.4. Photovoltaic-battery system
   3.5. Sizing battery system: the design process
4. Primary Power System
   4.1 Sequential Switching Shunt Regulator (S3R)
   4.2 Sequential Switching Shunt Series Regulator (S4R)
   4.3 Three Domain Control
   4.4 Maximum Power Point Tracking (MPPT)
   4.5 BDR and BCR.
   4.6 DC-DC Converters
5. Secondary power system and Protections
   5.1. Secondary power system
   5.2. Protections
   5.3. Redundancy vs Failure
   5.4. Other components of the power subsystem

LEARNING ACTIVITIES AND METHODOLOGY

AF1 Theoretical class
AF2 Practical classes
AF3 Practices in computer classroom
AF4 Laboratory practices
AF6 Group work
AF7 Individual student work
AF8 Evaluation activities

Code activity	Nº Total hours	Nº HoursPresencial	% Student's presence
AF1	103	103	100
AF2	45	45	100
AF3	28	28	100
AF4	14	14	100
AF6	67	0	0
AF7	400	0	0
AF8	24	24	100
TOTAL SUBJECT	682	215	32

Teaching methodologies that will be used in this subject

MD1 Exhibitions in the teacher's class with support of computer and audiovisual media, in which the main concepts of the subject are developed and the bibliography is provided to complement the students' learning.

MD3 Resolution of practical cases, problems, etc. raised by the teacher individually or in groups

MD5 Preparation of papers and reports individually or in groups

ASSESSMENT SYSTEM

EVALUATION SYSTEMS:

ASSESSMENT SYSTEMS OF THE STUDY PLAN REFERRED TO SUBJECTS

SE2 Partial exam or group work carried out during the course
SE3 Final exam

The course includes a written assessment valued 50%, and a partial exam or collaborative work valued 50% of the final mark. A minimum mark will be required in the written assessment.

In the extraordinary examination either continuous assessment or 100% final exam could be applied.

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

BASIC BIBLIOGRAPHY

- Mukund R. Patel Spacecraft power system, CRC Press , 2004; ISBN 9780849327865

- Peter Fortescue (Editor), Graham Swinerd (Editor), John Stark (Editor) Spacecraft Systems Engineering, 4th Edition, Wiley, 2011; ISBN: 978-0-470-75012-4

ADDITIONAL BIBLIOGRAPHY

- G. M. Hanley Satellite Power Systems (SPS) Concept Definition Study. Volume VII ¿ System/Subsystems Requirements Data book, NASA Contractor Report 3399, 1981