2EL1230 – Embedded space systems

Instructors: Laurent Bourgois
Department: DÉPARTEMENT ÉLECTRONIQUE ET ÉLECTROMAGNÉTISME
Language of instruction:
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 35,00
Elective Category : Engineering Sciences
Advanced level : No

Description

On-board space systems are complex systems developed for satellites, launchers or Mars rovers. They integrate hardware and software that must be robust and reliable to guarantee the success of space missions that will face a very hostile environment, especially radiation.
All these aspects, from strategic issues and missions to the detailed architecture of satellites, will be discussed with one objective: to acquire a global vision without sacrificing technical aspects.
A visit to Airbus Space Electronics will conclude this module and will allow to see in situation the concepts presented during the course.

Quarter number

SG6

Prerequisites (in terms of CS courses)

This course can be approached without any particular prerequisite for a domain. All necessary technical concepts will be explained during the module.

Syllabus

Presentation of space missions and systems
History and market of space.
Different types of space missions, launchers and orbits, satellites and manned flights.
The constraints of the space environment.

The satellite system
Description of a satellite: platform and payload.
Focus on automatic attitude and orbit control, thermal control and radiation.

On-board digital electronics

Specificity of space electronic systems. On-board functions.
Design of electronic boards and components (ASIC/FPGA).
Radiation hardening.

On-board software
The different on-board processing. Processors, memories and architectures used.
Focus on robustness, reliability, real time.
Validation of on-board software. Hardware/Software co-design.

Communications
Communication buses used (e.g. 1553 bus).
Payload and ground-to-air links: remote control and telemetry.
Link assessment and perspectives.

Energy management - Power
Solar panels, battery, electric propulsion, converters, power regulation, motor controls and actuators.
Mission profiles, eclipse management. Worst-case studies, stress share.

Reliability - Validation of space systems
Guaranteeing mission performance.
Redundancies. Fault tolerance: detection, decision, correction, reconfiguration, non propagation.
Ground testing and validation of space systems.

Visit of an industrial site
Airbus Defense and Space (Élancourt): engineering and clean rooms.

Translated with www.DeepL.com/Translator (free version)

Class components (lecture, labs, etc.)
Lectures given by different industry speakers for each module, experts in their field.

Grading
Evaluation in the form of a presentation on a topic related to space.

Resources
Teaching team composed of a CentraleSupélec referent (Laurent Bourgois) and speakers from industry (Airbus Defense and Space), experts in their field.

Learning outcomes covered on the course
At the end of this module, students will have a global knowledge of space systems and will be able to intervene in the design of an embedded system

operating in a hostile environment. They will understand how to cope with mechanical, thermal, radiative and electromagnetic stresses.
Emphasis will also be placed on the variety of activities related to embedded systems and on the interfaces with related professions: from silicon to the complete system, including software, validation and telecoms.

Description of the skills acquired at the end of the course

C1: Analyse, design and build complex systems.
C2: Develop skills in an engineering field and in a trade.