Cubesat platform: an introduction

Component
École Nationale Supérieure d'Électrotechnique d'Électronique d'Informatique d'Hydraulique et des Télécommunications

In brief

- **Ametys Code:** M34HL9UW
- **Open to exchange students:** Yes

Presentation

Objectives

Understand the various system constraints of the CubeSat platform.

Conduct a Phase A analysis of a satellite mission using a dedicated mission analysis tool.

Understand the various components involved in controlling the satellite's attitude and maintaining its orbit: SCAO system.

Implement satellite attitude control according to mission requirements.

Description

Lectures:
A. Dufour – CNES: Radiation and components
N. Verdier– CNES: the CubeSat programmes Nanolab Academy
J.L. Le Gal – CNES: Introduction to space mechanics
J.L. Le Gal – CNES: CNES concurrent engineering tools
CM: Attitude and orbit control system (SCAO)

Description of the different satellite modes (detumbling, pointing, tracking, end of life)
Description of actuators: gyroscope, magnetocouplers
Description of nanosatellite architecture (platform, payload, mechanical components)

Concepts of space mechanics:
Orbits
Coordinate systems: equatorial, ecliptic, geocentric, terrestrial, orbital, satellite, instrument
Satellite attitude representation:
MCD matrix, Euler angles, quaternion
Satellite attitude: kinematic and dynamic models, disturbing torques
Attitude simulator: digital twin
Actuator modelling
PID controllers
Control law based on quaternion description
CubeSat project:
Use of CNES concurrent analysis tools:
IDM-CIC: construction of a digital twin, data extraction (mass, inertia, consumption
Simu-CIC, IDM-View, VTS, STELA: Choice of orbit according to mission requirements (illumination vs. consumption, orbital lifetime, satellite attitude for mission completion, ground station visibility time, data volume)
Development of an in-orbit attitude propagator using Simulink
Implementation of an attitude control mode using MTQ and reaction wheels: detumbling, ground pointing