

Elastic metamaterials and actuators for space (Universeh)



Component
École Nationale
Supérieure
d'Électrotechnique
d'Électronique

In brief

- > **Amety's Code:** N9EE30B
- > **Open to exchange students:** Yes

Presentation

Objectives

- Understand basic wave phenomena and interactions in complex materials
- Understand the technical constraints associated with the space environment
- Be able to combine and apply dynamic phenomena to obtain the desired response from a structure
- Understand the concepts of mechanical impedance and multiple scattering
- Understand the design principles of metamaterials and be able to apply them to a specific application
- Understand the differences in dynamics between discrete and continuous systems
- Classify different actuation technologies and recognise their capabilities
- Verify application requirements in order to develop specifications
- Develop a multiphysics digital model to design the actuator

- Acquire/improve skills in teamwork, thinking and problem solving, task planning and coordination, breaking down problems into subtasks and interfacing them during work, project planning and verification

Description

Mechatronic space structures require specific solutions in terms of efficiency, robustness and precision for equipment that must operate for several decades without maintenance. In this context, piezoelectric technology combined with specific material properties can provide multi-domain solutions for actuation, mechanical isolation or energy recovery. Elastic metamaterials offer new possibilities in terms of dynamic mechanical response. Metamaterials are a new class of materials with extraordinary properties. In the context of dynamics, they can exhibit negative effective mass and/or stiffness, thus expanding the conventional design space for engineering materials. They can therefore be very interesting for the design of versatile, high-performance devices.

In this course, students will discover the applications of elastic metamaterials for various space mechatronic devices, in particular energy harvesters, actuators, sensors and electromechanical transformers, and will learn how metamaterials can be designed and used to significantly improve the dynamic properties of these systems. Students will have the opportunity to design a device, from theoretical principles to simulations, prototyping and electromechanical testing.

The course comprises eight sessions during which we present the necessary theoretical and practical knowledge, followed by four sessions devoted to a student project focused on the design, assembly and testing of a prototype device. Finally, students participate in an industrial-level project supported and supervised by high-level experts from the space sector.