

## Télécommunications

### Satellite Communications and Navigation

#### IDENTIFICATION

CODE : TC-5-S1-EC-SAT  
ECTS : 2.0

#### HOURS

Lectures : 12.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 32.0 h  
Personal work : 0.0 h  
Total : 32.0 h

#### ASSESSMENT METHOD

The course will be evaluated in two ways. On the one hand, the main content's final written exam (e.g., based on a multiple-choice scheme) must be passed. On the other hand, a hands-on project will be evaluated on a module-by-module basis to ensure the following modules are developed on solid ground.

#### TEACHING AIDS

The course content (five modules) will be provided in synchronous live lectures (presential or virtual, to be defined) with room for questions and answers between the students and the professor. Open discussions will be encouraged.

#### TEACHING LANGUAGE

English

#### CONTACT

M. FRAIRE Juan Andres  
juan-andres.fraire@insa-lyon.fr

#### AIMS

At the end of this course, participants will be able to recognize main space applications and actors, identify orbital parameters and design constellation fleets, select suitable orbital propagators, assess radiolocalization and navigation satellite systems, compute link budgets, design radiocommunication systems comprising satellites and launchers, understand communication protocols and multi-hop space networks and understand current market trends spanning the public and private sectors.

#### CONTENT

The Satellite Communications and Navigation course comprises five modules. Each module is provided by an expert on the specific domain.

Module 1 - Applications and Orbital Dynamics by J. Fraire (Inria)

Space applications and distributed missions

Trajectories and orbits, Keplerian laws, and orbital parameters,

Orbital perturbations and orbital propagators

Module 2 - Radiolocalization & Navigation (GNSS) by F. Marmet (CNES)

Radiolocalisation/radionavigation techniques

GNSS system and signals

GNSS receiver architecture and error budget and positioning performance

GNSS in urban environments and other complements

Module 3 - Radiocommunication (Physical layer, Launchers) by O. Bompis (CNES)

Radiofrequency systems in space

Frequency bands and coordination organisms

Ground station networks

Link budget computation

Module 4 - Markets & Actors (Current/Future Systems) by A. Terrasse (NATO)

Space applications

Satellite communication systems and their economics

Business considerations

Module 5 - Protocols & Networks (Link and Upper layers) by J. Fraire (Inria)

Link multiplexing and medium access control

Inter-Satellite link and space networks

Communication protocols and Internet limitations

Delay-tolerant networking for near-Earth and deep space systems

#### PRE-REQUISITE

Basic handling of maths, physics, and programming is welcome but optional. The course modules are approved with group-based projects where different disciplines can co-exist.