

Satellite Communications and Navigation (SAT)

Un module de la formation ingénieur Télécommunications de l'INSA Lyon

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The full "Satellite Communications and Navigation" course will be given in English (EN).

Compétence principale visée / Aimed main skill

Mastering satellite communications and navigation

Objectifs pédagogiques / educational goals

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.

Profil du participant / Participant Profile

The profile of the participant is comprehensive. The course assumes minimal starting knowledge. Thus, technical personnel in any industry (especially related to telecommunications and networks) can follow the course. Likewise, management staff will be able to acquire key technical skills behind space and satellite systems devoted to communications. No other constraints are identified. A personal laptop is suggested to follow up on the activities, but optional.

Prérequis / Prerequisites

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

Contenu de la formation / Training content

The "Satellite Communications and Navigation" course is organized into five modules. An expert on the specific domain provides each module.

External students are allowed to take individual modules if desired.

- 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)
 - Radiolocalization/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

Méthode pédagogique / Teaching method

The participants are integrated into the 5th year student groups in Telecommunications. The course content (five modules) is 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 are encouraged.

Evaluations et résultats / Evaluations and results

Written exam and group-based hands-on evaluation are not mandatory for external students. Participation certificates will be delivered if externals prefer not to give the exams. Otherwise, the course is evaluated in two ways.

1. On the one hand, the courses' main contents will be evaluated in a final written exam (e.g., based on a multiple-choice scheme).
2. On the other hand, small group-based hands-on projects will be evaluated on a module-by-module basis to ensure the following modules are developed on solid ground.

Durée / Duration

32 hours, from which 2 hours are dedicated to evaluation

Lieu de la formation / location of training

INSA Lyon, Bâtiment Eddy Lamarr

Équipe pédagogique / Educational team

Juan Fraire (Inria), Francois Marmet (CNES), Olivier Bompis (CNES), and André Terrasse (NATO)

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Partenaires / Partners

INRIA / CNES / NATO

Dates des sessions / Session dates : Autumn 2023