

ENV-542

Advanced satellite positioning

| Cursus | Sem. | Type |
|---|-------------|-------------|
| Environmental Sciences and Engineering | MA2, MA4 | Opt. |
| Mechanical engineering | MA2, MA4 | Opt. |
| Microtechnics | MA2, MA4 | Opt. |
| Robotics, Control and Intelligent Systems | | Opt. |
| Robotics | MA2, MA4 | Opt. |
| Space technologies minor | E | Opt. |

| | |
|----------------------|-------------------------------|
| Language of teaching | English |
| Credits | 4 |
| Withdrawal Session | Unauthorized Summer |
| Semester Exam | Spring During the semester |
| Workload Weeks | 120h 14 |
| Hours | 4 weekly |
| Courses | 2 weekly |
| Exercises | 1 weekly |
| TP | 1 weekly |

Number of positions

It is not allowed to withdraw from this subject after the registration deadline.

Remark

Pas donné en 2022-23

Summary

All fundamental principles behind modern satellite positioning to acquire, track and evaluate direct and indirect satellite signals and process them in relation to example applications: Earth monitoring (landslides,...), high precision positioning (automated driving, robots,...) and time transfer.

Content**Concept of satellite positioning**

- basic principals & reference frames
- orbit computation & simple positioning

Signal modulation and structure

- RF propagation in space
- signal structure including new Galileo modulations

Receiver technology

- signal preprocessing
- signal acquisition & tracking

Error models and differencing concepts for special and high precision applications

- code and carrier phase measurements
- linear combination of observations

Algorithms for reliable positioning

- code and carrier-phase smoothed-code
- carrier-phase cycle ambiguity determination

Algorithms for environmental sensing

- water vapor estimation
- total electron content estimation
- GNSS reflectometry

Keywords

GNSS, GPS, GLONASS, Galileo, satellite, positioning, signal modulation, detection, estimation, signal processing, ionosphere, troposphere, automated vehicles, space, time-transfer, Earth sensing, drones.

Learning Prerequisites

Recommended courses

Fundamentals of satellite positioning, signals and systems, or signal processing, estimation methods

Important concepts to start the course

Linear algebra, basic signal processing, statistics, programming in Matlab

Learning Outcomes

By the end of the course, the student must be able to:

- Implement signal acquisition and tracking
- Develop estimation procedure for precise positioning
- Interpret and analyse error sources as signal of environment
- Apply orbit calculation and algorithms for absolute positioning
- Synthesize a particular problem in GNSS for other students
- Solve carrier-phase ambiguities for cm-level positioning and ionosphere monitoring
- Choose an appropriate method and signals according to application

Transversal skills

- Make an oral presentation.
- Summarize an article or a technical report.
- Use both general and domain specific IT resources and tools

Teaching methods

Ex cathedra, exercises (part in computer room), demonstrations

Expected student activities

Active participation in the course and lab assignments, programming of algorithms and self-control (debugging), study of scientific papers.

Assessment methods

Continuous control, 3 tests on the following dates:

- 13th March 2020
- 1st May 2020
- 29th May 2020

Supervision

| | |
|--------------|-----|
| Office hours | No |
| Assistants | Yes |
| Forum | No |

Resources

Bibliography

Recommended literature on Moodle.

Notes/Handbook

Slides, book chapter and scientific papers distributed via Moodle.

Moodle Link

- <https://go.epfl.ch/ENV-542>

Prerequisite for

Sensor orientation