230378 - GNSS - Big Gnss Data: From Remote Sensing to Space Weather

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2020
Degree: MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019).
(Teaching unit Optional)
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 3
Teaching languages: English

Teaching staff
Coordinator: Hernandez Pajares, Manuel
Others: Hernandez Pajares, Manuel

Opening hours
Timetable: Wednesday, 11h-13h

Requirements
Basic knowledge of Mathematics and Physics (at the level of secondary education)

Degree competences to which the subject contributes

Specific:
CE5. Ability to design radio-navigation and location systems, as well as radar systems.

CEE13. Ability to analyze and evaluate the performance at the physical level of the main devices and sensors, the relations between magnitudes in their terminals and their equivalent circuits.

CE15. Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Teaching methodology
Application lectures
Expositive lectures
Personal work (non classroom)
Short-answer questions (Test)

Learning objectives of the subject
To introduce the basic concepts of Remote Sensing and Space Weather with the Global Navigation Satellite Systems
(GNSS)

Learning outcome:
He/she expresses clearly the process of planning and solving exercises and problems that require the use of GNSS.
He/she understands and masters the most useful methods to solve problems in the area of this subject.
He/she addresses numerical description and formulation of problems with descriptive description.
He/she makes use of more than one source and uses it in a complementary manner to observe the events described in the main text.
He/she identifies problems and models from open situations and explores alternative resolutions.

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group:</th>
<th>14h</th>
<th>18.67%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time: 75h</td>
<td>Hours small group:</td>
<td>10h</td>
<td>13.33%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>51h</td>
<td>68.00%</td>
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</tbody>
</table>
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## Content

### 1) Introduction to GNSS

<table>
<thead>
<tr>
<th>Description</th>
<th>Learning time: 19h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
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<tr>
<td></td>
<td>Self study: 15h</td>
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</tbody>
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- **1.1 Concept, signals and formats**
- **1.2 Segments**
- **1.3 Basic and precise models**

### GNSS tropospheric remote sensing

<table>
<thead>
<tr>
<th>Description</th>
<th>Learning time: 10h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
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<tr>
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<td>Self study: 8h</td>
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- **2.1 Tropospheric delay estimation with GNSS**
- **2.2 Application to the monitoring of extreme weather events (hurricanes, sudden river rise)**

### GNSS ionospheric remote sensing

<table>
<thead>
<tr>
<th>Description</th>
<th>Learning time: 21h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 8h</td>
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<tr>
<td></td>
<td>Self study: 11h</td>
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- **3.1 Ionospheric delay estimation with GNSS**
- **3.2 Practical lectures of introduction to Linux and IonSAT-tools**
- **3.3 Medium Scale Travelling Ionospheric Disturbances**
- **3.4 Tsunami warning and monitoring**

### Space Weather with GNSS

<table>
<thead>
<tr>
<th>Description</th>
<th>Learning time: 22h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
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<tr>
<td></td>
<td>Laboratory classes: 2h</td>
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<tr>
<td></td>
<td>Self study: 16h</td>
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</tbody>
</table>

- **4.1 Geomagnetic storm footprint in GNSS**
- **4.2 Solar flare detection and measurement with GNSS**
- **4.3 Achievement in Feb. 2020: Stellar flare detection and measurement with GNSS**
## Planning of activities

<table>
<thead>
<tr>
<th>Presentations of Academic ITT proposal</th>
<th>Hours: 2h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Self study: 1h</td>
</tr>
<tr>
<td></td>
<td>Theory classes: 1h</td>
</tr>
</tbody>
</table>

**Description:**
Presentations of the Academic-ITT proposal

<table>
<thead>
<tr>
<th>Final exam</th>
<th>Hours: 2h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
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</table>

**Description:**
Final test

## Qualification system

The assessment is based on:
1. The answers to the questionnaire of the lab session at point unit 3 (20%)  
2. The proposal the students have to submit individually (or in pairs) and defend (30%), as an answer to an "Academit Intended To Tender" (aITT) posed by the teacher, emulating the European Space Agency (ESA)  
3. Final exam (50%).

In this subject the generic competences will be evaluated:
- Autonomous learning (Elementary level)  
- Ability to identify, formulate and solve engineering problems (Elementary level)
Bibliography

Basic:


Complementary:


Singh, T., Hernandez-Pajares, M., Monte, E., Garcia-Rigo, A., & Olivares-Pulido, G.. "GPS as a solar observational instrument: