

## Course guides

### 19396 - R - Radio Navigation

**Last modified:** 04/12/2020

**Unit in charge:** Castelldefels School of Telecommunications and Aerospace Engineering  
**Teaching unit:** 749 - MAT - Department of Mathematics.  
748 - FIS - Department of Physics.

**Degree:** MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2015). (Optional subject).

**Academic year:** 2019    **ECTS Credits:** 5.0    **Languages:** English

#### LECTURER

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**Coordinating lecturer:** Defined in the course webpage at the EETAC website.

**Others:** Defined in the course webpage at the EETAC website.

#### PRIOR SKILLS

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Operativity with the concepts, magnitudes and basic laws of Physics preferably with some knowledge of astrodynamics.  
Operationality with algebraic and statistical data functions.  
Ability to perform application programs in Matlab / Octave or C # language or similar.

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

CE3 MAST. (ENG) CE3: Aplicar los métodos numéricos para ingeniería aeroespacial con especial énfasis en sus aplicaciones, y en especial en la dinámica de fluidos.

CE6 MAST. (ENG) CE6: Realizar, presentar y defender ante un tribunal universitario un ejercicio original realizado individualmente, consistente en un estudio de investigación en el campo de la Ingeniería Aeroespacial, en el que se sinteticen las competencias adquiridas en las enseñanzas, adoptando los avances y novedades en este campo y aportando ideas novedosas.

**Generical:**

CG2 MAST. (ENG) CG2: Identificar y aplicar los análisis teóricos, experimentales y numéricos fundamentales de uso actual en ingeniería aeroespacial.

**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.

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

**Basic:**

CB8. (ENG) CB8 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios.

CB9. (ENG) CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades.

CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

CB10. (ENG) CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

## TEACHING METHODOLOGY

The classes of the subject will be presential and expositive. Teaching material will be composed of PowerPoint presentations (which can be obtained from the first day) and links to pages and publications of special relevance. A devoted software, the GNSS-Lab Tool suite (gLAB), will be used in assisted laboratory group work supervised by the professors of the subject. Students will have to do a project of one selected topic of the subject, doing their exposition at the end of the course.

In particular, the formative activities applied during the course will be:

A01: Master classes (theory lectures)

A04: Assisted laboratory work (practical exercises)

A06: Project based learning

## LEARNING OBJECTIVES OF THE SUBJECT

Theoretical-practical study of the different navigation algorithms for Global Navigation Satellite System System (GNSS) to provide the student with a rigorous knowledge about the GNSS data processing. It is promoted the adquisition of the instrumental use of concepts and techniques in GNSS-based navigation.

## STUDY LOAD

| Type              | Hours | Percentage |
|-------------------|-------|------------|
| Hours large group | 45,0  | 36.00      |
| Self study        | 80,0  | 64.00      |

**Total learning time:** 125 h

## CONTENTS

### Theory of Global Navigation Satellite System (GNSS) data processing

#### Description:

Lecture 0: Introduction

Lecture 1: GNSS measurements and their combinations

Lecture 2: Satellite orbits and clocks computation accuracy

Lecture 3: Position estimation with pseudoranges

Lecture 4: Introduction to DGNSS

Lecture 5: Precise positioning with carrier phase (PPP)

Lecture 6: Differential positioning with code pseudoranges

Lecture 7: Carrier based differential positioning. Ambiguity resolution techniques

#### Related competencies :

CG2 MAST. (ENG) CG2: Identificar y aplicar los análisis teóricos, experimentales y numéricos fundamentales de uso actual en ingeniería aeroespacial.

CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

CB10. (ENG) CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

**Full-or-part-time:** 22h 30m

Theory classes: 22h 30m



## Laboratory exercises of Global Navigation Satellite System (GNSS) data processing

### Description:

Tutorial 0: UNIX environment, tools and skills. GNSS standard file formats  
Tutorial 1: GNSS data processing laboratory exercises  
Tutorial 2: Measurement analysis and error budget  
Tutorial 3: Differential positioning with code measurements  
Tutorial 4: Differential positioning and carrier ambiguity fixing  
Tutorial 5: Analysis of propagation effects from GNSS observables

### Related competencies :

CE3 MAST. (ENG) CE3: Aplicar los métodos numéricos para ingeniería aeroespacial con especial énfasis en sus aplicaciones, y en especial en la dinámica de fluidos.

CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

CB10. (ENG) CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CB9. (ENG) CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades.

**Full-or-part-time:** 22h 30m

Theory classes: 22h 30m

## GRADING SYSTEM

Defined in the course webpage at the EETAC website.

## EXAMINATION RULES.

All the evaluation activities proposed are mandatory. An exam, deliverable or project not presented will be scored with a zero note. The examinations will be carried out individually, the project will be carried out in group and the delivery of problems can be both group and individual. The writing exam is open book. Students can bring any material to the assessment except internet/communication devices.

## BIBLIOGRAPHY

### Basic:

- Sanz Subirana, Jaume; Juan Zornoza, J. Miguel; Hernández Pajares, Manuel. GNSS data processing. Noordwijk: ESA Publications Division, cop. 2013. ISBN 9789292218867.
- Misra, Pratap; Enge, Per. Global positioning system : signals, measurements, and performance. 2nd ed. Lincoln: Ganga-Jamuna, cop. 2006. ISBN 0970954417.
- Hofmann-Wellenhof, Bernhard; Lichtenegger, Herbert; Collins, James. Global positioning system : theory and practice. 4th ed. revised. Wien ; New York: Springer-Verlag, cop. 1997. ISBN 3211828397.

### Complementary:

- Hernández Pajares, Manuel; Juan Zornoza, J. Miguel; Sanz Subirana, Jaume. GPS data processing : code and phase : algorithms, techniques and recipes [on line]. 1st ed. (English). Barcelona: Centre de Publicacions del Campus Nord, UPC, DL 2005 [Consultation: 17/04/2020]. Available on : [https://gagc.upc.edu/sites/default/files/TEACHING\\_MATERIAL/GPS\\_BOOK/ENGLISH/PDGPS/BOOK\\_PDGPS\\_gAGE\\_NAV\\_08.pdf](https://gagc.upc.edu/sites/default/files/TEACHING_MATERIAL/GPS_BOOK/ENGLISH/PDGPS/BOOK_PDGPS_gAGE_NAV_08.pdf). ISBN 8493223050.

## RESOURCES

### Audiovisual material:



- Course Slides (Theory & Laboratory). Course Slides (theory & laboratory)

**Computer material:**

- GNSS-Lab Tool (gLAB). An interactive educational multipurpose package to process and analyse GNSS data.

**Other resources:**

[www.gage.upc.edu/tutorials](http://www.gage.upc.edu/tutorials)