# *Name of the Subject GEODESIC POSITIONING SYSTEMS*

*Emphasis*

**NAME OF THE SUBJECT**: **39503002**
**GEODESIC POSITIONING SYSTEMS**

- Obligatory ( ): Basic ( ) Complementary ( )
- Elective (**X**): Intrinsic ( ) Extrinsic ( )

NUMBER OF ACADEMIC CREDITS: Four (4).

**COURSE TYPE: THEORETICAL: ___ PRACTICAL: ___ THEORETICAL-PRACTICAL: _X_**
Methodological alternatives:
Master Class (**X**), Seminar ( ), Seminar - Workshop (X), Workshop ( ), Practice (X),
Tutored projects (**X**), Other: _____

## *Justification*

**SYNOPSIS OF THE SUBJECT:**

Learn systems and frameworks geodetic in GNSS

**JUSTIFICATION:**

The subject Geodetic Positioning Systems, of the emphasis in Geomatics of the Master in Information Sciences and Telecommunications, will allow students to have the basic foundations of Geodesy, in order to understand the importance of spatial data (which correspond to geographic information referenced) as an input for the thematic maps and Geoscience projects.

This subject will allow the student to have essential knowledge to face the challenges of the 21st century of Geodesy, which are oriented to the following areas of knowledge: Climate change, atmospheric dynamics, natural hazards, accurate orbit determination, ice and glacier dynamics, sea level and ocean dynamics, hydrology, Geodynamics and tectonic plates, bathymetry and topography, operational and engineering geodesy, reference frameworks global and natural risk management

**PREREQUISITE:** None

## *Content*

General description Teach systems and frameworks geodetic in GNSS

### GENERAL OBJECTIVE

Teach the student of the master's in information and Communication Sciences (Emphasis on Geomatics) scientific elements of Geodetic Positioning, which guarantee a theoretical and practical knowledge of GNSS and its applications in Earth Sciences

### SPECIFIC OBJECTIVES

- Provide the mathematical and conceptual foundation for GNSS systems applied to Earth Sciences, with which a processing according to international standards is carried out in the determination of geodetic coordinates

- Assurance that the student can analyze, process and carry out projects of GNSS satellite positioning systems and their applications in the areas of knowledge that allow understanding the natural phenomena present on earth

### SYNTHETIC PROGRAM:

Contents

1.INTRODUCTION

1.1. Basic Concepts of Satellite Geodesy

1.2. GNSS Reference Systems and Frames

1.3. Cartesian and Ellipsoidal Coordinates and transformations

1.4. Systems and Reference Frames (Conventional Terrestrial Reference System CTRS, CIRS)

1.5. Reference Ellipsoid, Geoid and WGS84, Cartesian Projections, Heights

1.6. Regional Datums and Map Projections

2 GNSS Architecture

2.1 GNSS Segments

2.1.1 Space Segment

2.1.2 Control Segment

2.1.3 User Segment

2.2 GNSS Signals

2.2.1 GPS Signals

3. Time GNSS
3.1. Sidereal Time and Universal Time
3.2. Atomic Time and GPS
3.3. Ephemeris, Dynamic Time and Earth Time
3.4. Clocks

4. Satellite Orbits
4.1. Keplerian Elements
4.2. GNSS Broadcast Orbits
4.3. Measurements and Data Preprocessing
4.4. Combinations of GNSS Measurements
5. Atmospheric Effects Modelling
5..1 Ionospheric Delay
5.2 Tropospheric Delay
5.3 Antenna Phase Centre Correction
5.4 Earth Deformation Effects Modelling
5.5 Solid Tides
5.6. Ocean Loading
5.7. Pole Tide

6 Solving Navigation Equations
6.1 Basic Concepts: Code-Based Positioning
6.1.1 Parameter Adjustment
6.1.2 Kalman Filter
6.1.3 Positioning Error
6.2 Code and Carrier-Based Positioning
6.2.1 Precise Modelling Terms for PPP

7. GNSS Positioning Methods and applications
7.1. Differential method
7.2. Kinematic method
7.3. Method (Positioning by Precise Point) PPP
7.4. Applications in Geodynamics

7.5. Application Geophysics (Seismology, Volcanism, Mass Movements, Subsidence)
7.6. Applications in Oceanography
7.7. Applications in Meteorology

## *Strategies*

**METHODOLOGY:**

| | Hours | | | Teacher hours / week | Student hours / week | Total Hours Student / semester | Academic credits |
|---|---|---|---|---|---|---|---|
| **Type of course** | DW | CW | AW | (DW + CW) | (DW + CW +AW) | X 18 weeks | |
| **THEORETICAL-PRACTICAL** | 3 | 1 | 3 | 4 | 7 | 112 | 3 |

**Direct Presential Work (DW):** classroom work in plenary session with all students.
**Mediated-Cooperative Work (CW):** Teacher tutoring work to small groups or individually to students.
**Autonomous Work (AW):** Student work without the presence of the teacher, which can be done in different instances: in work groups or individually, at home or in a library, laboratory, etc.)

## *Resources*

PHYSICAL RESOURCES REQUIRED:

1. Master class
2. Directed and assigned workshops
3. Analysis of case studies
4. Use of updated GNSS websites
5. Exhibitions of the final projects of the subject by the students

BIBLIOGRAPHY:

GUIDING TEXTS

• Sanz, J., Subirana, J.M. Zornoza J and Hernández-Pajares M., 2013 GNSS DATA PROCESSING Volume I and II: Fundamentals and Algorithms, Eropean Space Agency -

ESA

• Misra P., Egne P. (2012). Global Positioning System. Signal, Measurements and Performance. Bargain- Jamuna Press, 2nd Edition

• Groves P.D. (2007) Principles of GNSS, Inertial, and Multi-sensor Integrated Navigation Systems (GNSS Technology and Applications). Artech Print on Demand.

• Günter Seeber. Satellite Geodesy. 2nd completely revised and extended edition. Walter de GruyterBerlinNew York 2003, 589 p

• Hoffmann-Wellenhof B., H. Litchtenegger and E. Wasle, (2008), GNSS: Global Navigation Satellite Systems, Springer, 516 p.

• Wolfgang Torge (2001) Geodesy Walter de Gruyter - New York 2001, 434 p

COMPLEMENTARY TEXTS

• Jing-xiang G. and Hong H., (2009), Advanced GNSS technology of mining deformation monitoring, The 6th International Conference on Mining Science & Technology, Procedia Earth and Planetary Science 1, 1081–1088

• Lorimer R. and G. Roberts, (2010), Mining Boom Spurs New Positioning Solutions, In: GPS World, May 19, 2010.

• Malys S., J. Slater, R. Smith, L. Kunz and S. Kenyon, 1997, Refinements to the World Geodetic System 1984, Proc. of the 10th ION Technical Meeting, Kansas City, Missouri

• NIMA, (2000), World Geodetic System 1984, Its Definition and relationships with Local geodetic Systems, DoD, NIMA TR835202, 3d. Ed., Amendment 1

**Web Site addresses:**

Antennas ftp://igs.org/pub/station/general/antenna_README.pdf
Antennas http://www.ngs.noaa.gov/ANTCAL/
IGS ftp://igs.org/pub/station/general/igs14.atx
NOAA http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=ngs14.atx
NOAA http://holt.oso.chalmers.se/loading/
SPEEDS http://www.sirgas.org/pt/velocity-model/
Coordinates http://mycoordinates.org/
Geoinformatics http://www.geoinformatics.com/
Geospatial World http://www.geospatialworld.net/

Geoworld http://www.geoplace.com
GIM International http://www.gim-international.com/
GPS World http://www.gpsworld.com/
Inside GNSS http://www.insidegnss.com/magazine
International Journal of Geoinformatics http://www.geoconnexion.com
MundoGeo http://mundogeo.com
Professional Surveyor http://www.profsurv.com

INTERNET ADDRESSES International GNSS Service - http://igscb.jpl.nasa.gov/
The International Terrestrial Reference Frame ITRF, website: http://itrf.ensg.ign.fr/
SIRGAS: Reference System for the Americas, website: http: // http://www.sirgas.org
GEORED Project, Colombian Geological Service http://geored.sgc.gov.co
CORS Project - District University https://rita.udistrital.edu.co/gps/#datos
UNAVCO - https://www.unavco.org/
IGAC - https://geoportal.igac.gov.co/contener/datos-abierto-geodesia

BIBLIOGRAPHIC RESOURCES:

- IEEE Database
- SPRINGER Database
- ELSEVIER Database

## *Course Schedule*

| Week /Unid | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Introduction, GNSS Architecture and GNSS Time | X | X | X | X | | | | | | | | | | | | |
| 2. Satellite Orbits and Modeling of Atmospheric Effects | | | | | X | X | X | X | | | | | | | | |
| 3. Solve the navigation equations | | | | | | | | X | X | X | X | | | | | |
| 4. GNSS positioning methods and applications and the Materia Project | | X | | | | X | | | | | | X | X | X | X | X |

# *Evaluation*

**ASPECTS TO EVALUATE**

**Competentes**

- It is thought that the Magister have the foundations of geodesy, the acquisition and processing of GNSS data
- With the foundation in geodesy you can make applications in Earth Sciences
- There will be adequate competence in Geodesy for proper professional performance

| | TYPE OF EVALUATION | DATE | PERCENTAGE |
|---|---|---|---|
| **FIST NOTE** | Theoretical evaluation of basic GNSS concepts generally with a written work | 4 week | 30% |
| **SECOND NOTE** | Assessment of assigned workshops of the different topics of the course | 7 to 10 weeks | 40% |
| **FINAL NOTE** | Final written project and exposition by the students | 13 to 16 weeks | 30% |

**TEACHER INFORMATION:**

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