Affiliated to the UN

Global Navigation Satellite System

Modules of the Master

February 2013

Materials of Semester 1	Contents	VH
Module 1 : Basic Mathematics		**80**
Reminders Mathematics	• Complex analysis • Numerical Analysis • Geometry of surfaces	25
Signal processing	• Basics of analog signal processing and digital • Fourier analysis • Signal acquisition • Signal processing	25
Statistics	• Descriptive analysis (mean, standard deviation, variance ...) • Statistical modeling of spatial data • Interpolation methods	30
Module 2 : Basic physical		**80**
Electronics	• Mathematical Foundations • Electrical signals • Electronic components • Electronic circuits • Transmitters, sensors	30
Space mechanics	• Components and types of satellites • Keplerian Elements • Modeling the movement of satellites • Description and orbit determination	30
Earth Physics	To be completed by the team of the Scientific Institute	20
Module 3 : Computers		**80**
Databases	• Development cycles • Stages of design • Relational databases • Database objects • Analysis databases	16
Object-Oriented Programming	• Fundamental OO programming • Encapsulation, inheritance and polymorphism • Constructors and destructors • Virtual methods, dynamic and abstract • Visibility • Variables and Operators • Conditions and loops and arrays • Class methods • Classes • Object modeling	24
Network architecture and protocols	• Signaling and modulation • LAN • Connection diagrams • Data Services • TCP / IP • ATM	24

Embedded Systems	• Types of embedded systems • Features and Architecture • Programming languages • Fields of application	16
Module 4 : Signals and Receivers		**80**
Structure and transmission of signals	• Standard signal transmission • Signal structure • Signal Processing • Coding techniques	40
Receivers	• Architecture receivers • Types of antennas and components • Propagation of electromagnetic waves • Atmospheric effects • Sources of errors • Navigation algorithms • Filtering • Modulation techniques	40
Materials of Semester 2	**Contents**	**VH**
Module 5 : Fundamentals of Geodesy and Topography		**80**
Geodesy	• Ellipsoid of revolution • Types of repositories • Geodetic coordinate systems • Transformations between coordinate systems • Measurements and errors in geodesy • Law of propagation of errors • Principle of least squares • Compensation methods : Method of condition method of variation of parameters • Map projections	50
Physical geodesy	• Gravimetry • Leveling • Geoid determination.	12
Digital topography	• Measures of angles, distances and height differences • Measurement errors • Processes topographic horizontal and vertical • Survey methods and Instrumentation digital survey • Processing and automatic establishment plans	18
Module 6 : Positioning Satellite		**80**
Introduction to Systems Global Navigation Satellite System (GNSS)	• Scientific positioning systems. • Study of global systems GPS, GLONASS, Galileo, COMPASS : – Historical – Segments – Reference systems – Services available – Signal structure and messages • Regional systems (IRNSS, QZSS, ..)	20
Processing GNSS observations	• Types of GNSS measurements	60

	• Noise measurements • Mathematical model by measuring Doppler • Mathematical model by measuring pseudorange • Mathematical model by phase measurement • Linearization and filtering • Detection of cycle slips • Combination of measures • Resolution of ambiguities • Methods adjustments • Quality indicators positioning	
Module 7 : Techniques for positioning and navigation satellite		***80***
Technical positioning and navigation	• Autonomous positioning methods • Methods of precise positioning • Dynamic positioning methods	40
Differential positioning and augmentation systems	• Principle • Differential systems • Solution of differential positioning • Augmentation systems (EGNOS, WAAS, MSAS, GAGAN) • Assisted positioning • Geo-location by mobile network • Permanent stations	40
Module 8 : Practices positioning techniques		***80***
Precise static positioning		40
Kinematic positioning and real-time kinematic		40
Materials of Semester 3	**Contents**	**VH**
Module 9 : Representation of geographic data		***80***
Cartography	• Representation of topographic data • Representation of qualitative and quantitative data • Preparation of maps and Skin	20
Web-Mapping	• Foundations, software architectures, programming languages, standards.	20
Design of geographic databases		20
Mini-Project (part [1] of the pilot project)	Thematic applications of GNSS	20
Module 10 : Management of geographic data		***80***
Geographic Information Systems	• Components of GIS • Data Types • Acquisition and Preprocessing • Spatial analysis • Thematic analysis • Spatial modeling • Geographic databases • Standards	50
Mini-Project [2nd] part of the pilot project)	Thematic applications of GNSS	30
Module 11 : GNSS Applications thematic and Complementary Systems		***80***
Thematic applications	• Geodesy, Photogrammetry and Cartography	40

	• Civilian navigation • Civil engineering works and auscultation • Precision agriculture and natural resources • Lands, cadastre • Disaster Monitoring • Regulatory and Legal Aspects of GNSS	
Inertial systems	• Operating principle and Technologies • Measuring acceleration, angle and angular velocities • Reckoning • Coupling (reckoning and satellite navigation)	20
Mini-Project (3rd element of the pilot project)	Thematic applications of GNSS	20
Module 12 : Communication and Project Management		***80***
Technical English		20
Project Management		20
Mini Project (4th element of the pilot project)	Thematic applications of GNSS	40
Materials of Semester 4	**Contents**	**VH**
Module 13, 14, 15, 16: Final Project study		***320***

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