Course Guide
43742 Laboratory of instrumentation

COURSE DATA

Data Subject	
Code	43742
Name	Laboratory of instrumentation
Cycle	Master's degree
ECTS Credits	5.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2162 - M.U. en Teledetección 12-V.2	Faculty of Physics	1	First term

Subject-matter

Degree	Subject-matter	Character
2162 - M.U. en Teledetección 12-V.2	1 - Fundamentals	Obligatory

Coordination

Name	Department
COLL COMPANY, CESAR	345 - Earth Physics and Thermodynamics

SUMMARY

The Instrumentation Laboratory course, together with the Fundamentals of Remote Sensing, compose the Fundamentals subject where the physical principles of remote sensing are provided and the students get familiar with the proper instrumentation of remote sensing measurements. In the specific laboratory part, the student uses basic measuring instrumentation that allows for the measurement of physical parameters for their comparison or calibration/validation of the measurements taken from satellites.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

Not special previous requirements

OUTCOMES

2162 - M.U. en Teledetección 12-V.2

- Students can apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
- Students are able to integrate knowledge and handle the complexity of formulating judgments based on information that, while being incomplete or limited, includes reflection on social and ethical responsibilities linked to the application of their knowledge and judgments.
- Students can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences, clearly and unambiguously.
- Students have the learning skills that will allow them to continue studying in a way that will be largely self-directed or autonomous.
- Be able to access the information required (databases, scientific articles, etc.) and to interpret and use it sensibly.
- Students have the knowledge and understanding that provide a basis or an opportunity for originality in developing and/or applying ideas, often within a research context.
- Be able to access to information tools in other areas of knowledge and use them properly.
- Exponer y defender públicamente el desarrollo, resultados y conclusiones de su trabajo de una manera clara y concisa.
- Trabajar en equipo con eficiencia.
- Ser capaces de realizar una toma rápida y eficaz de decisiones.
- Aplicar los conocimientos adquiridos con criterios de sostenibilidad de nuestro entorno.
- Entender los fundamentos físicos de la Teledetección y ser capaz de aplicarlos en el análisis y tratamiento de los datos.
- Entender el funcionamiento de los sensores de teledetección y el proceso de calibrado de los mismos, saber utilizar la instrumentación necesaria para la medida de magnitudes radiométricas y parámetros biofísicos y saber realizar el tratamiento y análisis de los datos que proporcionan.

At the end of the teaching-learning process, the student should be able to:

1. Know the different types of remote sensing platforms and sensors

2. Know the basic parameters that define the remote sensing images

3. Understand and assimilate the fundamental concepts concerning radiometric quantities

4. Understand the concept of reflectance and get to know the factors that influence the reflectance of different natural surfaces and know the most used vegetation indices as well

5. Understand and assimilate the various forms of interaction of electromagnetic radiation with matter

6. Understand the different terms that appear in the atmospheric radiative transfer equation

7. Understand the various corrections required by remote sensing images both in the optical and the thermal infrared domains

8. Understand the basics of remote sensing in the microwave part of the spectrum

9. Understand the operation of radiometers, carry out measurements with them and with other instruments measuring biophysical parameters, and perform and interpret instrument calibration

10. Programming complex calculations or use spreadsheets to evaluate errors in the development of experimental work. Structure the information about the work developed in the laboratory so that it can be reproducible by others

DESCRIPTION OF CONTENTS

1. Spectroradiometers Characterization

The objective of this practical is to characterize two different spectroradiometers. This implies their respective calibration, analysis of their spectral and angular responses, accuracy determination and influence of temperature on their measurements.

2. Radiometric Measurements on Natural Surfaces

The objective of this practical is to get to know the procedure for spectrometric measurements and the spectral responde of some natural surfaces. The practical then consists of performing a series of radiometric measurements over some natural surfaces by using the GER-1500 radiometer.

3. Calibration and Use of the ESA ELBARA II, an L-Band Radiometer System for Soil Moisture Research

L-band (12 GHz) microwave radiometry is a remote sensing technique that can be used to monitor soil moisture, and is deployed in the Soil Moisture and Ocean Salinity (SMOS) Mission of the European Space Agency (ESA) and in the SMAP (Soil Moisture Active and Passive) NASA Mission. Performing independent ground-based radiometer measurements is important for validating the satellite data and products and for the further improvement of the radiative transfer models used in the soil-moisture retrieval algorithms. The objective of this practical is to obtain microwave brightness temperature measurements from a vine with the help of the calibrated microwave observations of different controlled sources.

4. Radiometer Calibration in the Thermal Infrared. Measurement of Emissivity: the Box Method

Learn how to use different thermal infrared (TIR) radiometers devoted to the measurement of the land surface temperature. Calibrate the radiometers with a black body of variable temperature. Measure the emissivity of two soils in different TIR spectral bands using the Box method. Analysis of results according to the sample composition.

5. In-situ measurement of biophysical parameters of vegetation canopy

The objective of this exercise is to learn the principles of the methodology for in-situ determination of biophysical variables of vegetation canopy. In particular, the chlorophyll content will be determined using the SPAD-502 (MINOLTA) and CCM-200 (OPTI-SCIENCES) instruments. The leaf area index (LAI) and the fraction of vegetation cover (FVC) will be measured using the LAI-2000 (LICOR) instrument.

WORKLOAD

ACTIVITY	Hours	% To be attended
Laboratory practices	25,00	100
Tutorials	5,00	100
Development of individual work	60,00	0
Study and independent work	15,00	0
Readings supplementary material	20,00	0
TOTAL	**125,00**	

TEACHING METHODOLOGY

A total number of five laboratory practicals will be carried out by the students. These take place in small groups (16 students), with a lecturer in charge of each subgroup. The sessions are dedicated to proper laboratory experiments where the students carry out the experimental setup and data collection. For each practical, the student must submit a report with experimental data collected and processed (errors, graphic settings, adjustments), as well as the conclusions drawn.

EVALUATION

The laboratory work is evaluated, for both the first and second calls, on the basis of the respective reports handed in by the students for each of the practicals carried out during the course (5 in total). Each report is marked between 0 and 10, and the final mark is obtained by averaging all the laboratory report marks where **each individual mark should be above 5 (out of10). Laboratory attendance is considered compulsory**

REFERENCES

Basic

- Introduction to radiometry, William L. Wolfe. Tutorial Texts in optical engineering. SPIE optical engineering press, 1998.
- An Introduction to solar radiation, Muhammad Iqbal. Academic press, 1983
- ELBARA II, an L-Band Radiometer System for Soil Moisture Research. Mike Schwank , Andreas Wiesmann , Charles Werner, Christian Mätzler , Daniel Weber , Axel Murk 3, Ingo Völksch and Urs Wegmüller. Sensors 2010, 10, 584-612; doi:10.3390/s100100584
- McCLUNEY, R.W. (1995) Introduction to Radiometry and Photometry. Ed. Artech House. Boston.
- Rubio, E., Caselles, V., and Badenas, C. (1997). Emissivity measurements of several soils and vegetation types in the 8-14 ìm wave band: Analysis of two field methods. Remote Sensing of Environment, 59:490-521

- Gandía, S., Moreno, D., Moreno, J., Morales, F., Sagardoy, R. (2006). Calibration of instruments for indirect determination of chlorophyll content and analysis of in-situ chlorophyll measurements during the SEN2FLEX campaigns. SEN2FLEX WORKSHOP-ESA/ESTEC / 30 - 31 October, 2006. Noordwijk, The Netherlands.
- Jonckheere, I., Fleck, S., Nackaerts, K., Muys, B., Coppin, P., Weiss, M., Baret, F. (2004). Methods for leaf area index determination. Part I: Theories, techniques and instruments. Agricultural and Forest Meteorology, 121:1935.
- Weiss, M., Baret, F., Smith, G. J., Jonckheere, I., Coppin, P. (2004). Review of methods for in situ leaf area index (LAI) determination. Part II. estimation of LAI,errors and sampling. Agricultural and Forest Meteorology, 121:3753.
- Welles, J. M., Norman, J. M. (1991). Instrument for indirect measurement of canopy architecture. Agronomy Journal, 83:818825.

Additional

- Progress in field spectroscopy, Milton, E.J., Schaepman, M.E., Anderson, K., Kneubühler, M., Fox, N., Remote Sensing of Environment 113 (Supplement 1):S92-S109, 2009.
- MILTON, E., SCHAEPMAN, M.E, ANDERSON, K., KNEUBHLER, M, FOX, N. (2009). Progress in field spectroscopy. Remote Sensing of Environment, 113, S92-S109.
- L-Band Radiative Properties of Vine Vegetation at the SMOS Cal/Val Site MELBEX III. Schwank, Mike, Jean-Pierre Wigneron, Ernesto Lopez-Baeza, Ingo Völksch, Christian Mätzler, Yann Kerr. IEEE Trans. on Geoscience and Remote Sensing (TGRS) SMOS Special Issue, vol. 50, issue 5, 1587-1601
  First evaluation of the simultaneous SMOS and ELBARA-II observations in the Mediterranean región. Wigneron, Jean-Pierre, M. Schwank, E. Lopez Baeza, Y. Kerr, N. Novello, C. Millan, C. Moisy, P. Richaume, A. Mialon, A. Al Bitar, F. Cabot, H. Lawrence, D. Guyon, J-C Calvet, J. P. Grant, P. de Rosnay, A. Mahmoodi, S. Delwart, S. Mecklenburg. Remote Sensing of Environment, Volume 124, September 2012, Pages 2637