Course Unit	GIS and Precision Viticulture			Field of study	Land Sciences								
Bachelor in	Oenology			School	School of Agriculture								
Academic Year	2023/2024	Year of study	2	Level	1-2	ECTS credits	6.0						
Type	Semestral	Semester	1	Code	9998-705-2103-00-23								
Workload (hours)	162	Contact hours	T -	TP 60	PL -	TC -	S -	E -	OT 4	O -			

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): João Paulo Miranda Castro

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Learn to map using Geographic Information Systems and use the various applications covered in the course with skill and autonomy.
2. Know and apply techniques for the acquisition of Geographic Information supported by field surveys and by remote sensing data.
3. Acquisition and processing of aerial and satellite images for Earth observation.
4. Know and apply global navigation satellite systems for monitoring and control of field equipment and surveys.
5. To learn about emerging technological solutions for precision viticulture integrating the technologies described above with sensors, robots, drones, which help monitor the vineyard
6. Apply emerging technological solutions in the evaluation of health, physiology, vigour, ripeness control, climatic data, from planting to harvesting.
7. To learn analysis criteria to assess the relationships between soil, geomorphometry and microclimate, and to understand differentiating factors of terroirs and disturbance factors.

Prerequisites

Before the course unit the learner is expected to be able to:
1. To understand the phenomena of viticultural ecology
2. To know the national viticultural regions and their main cultural systems
3. Recognise the usefulness of cadastre, topography, cartography and remote sensing in wine management
4. To have a basic knowledge of statistics and computing in viticulture management
5. To recognise the vulnerabilities of viticulture due to climate change and labour constraints

Course contents

Geographic Information (GI) and GIS. Coordinate systems, projections and transformations. Geographic Database Management Systems. Models of data structure: Vector and Raster. GNSS. Acquisition, editing, manipulation and analysis of GI. Geomorphometry and Digital Terrain Models. Remote sensing. Sensors. Digital image processing (IP). Integration of GIS, DR and IP in vineyard monitoring. Criteria and strategies for vineyard zoning (terroir).

Course contents (extended version)

1. Geographic information. Introduction to GIS. History, definitions and components
   - Coordinate systems and georeferencing
   - Features and attributes
   - Database Management Systems
   - Relational models of data structures in GIS
   - Topology
   - Toponymy
   - Acquisition, edition, manipulation and analysis of geographic information in GIS
   - Spatial queries, overlapping, intersection
   - Advanced GIS editing techniques - Computer Aided Design (CAD) tools
   - Development of applications in viticulture with the open access GIS programs QGIS and SAGA-GIS.
2. Remote Sensing Systems and Digital Image Processing
   - Interaction of electromagnetic radiation with earth surface and atmosphere
   - Passive sensors (multispectral, thermal, . . .) and active sensors (RADAR, LiDAR, . . .)
   - Image characteristics (spatial, temporal, spectral and radiometric resolution)
   - Platforms: satellites, piloted aircraft and Unmanned Aerial Vehicles (UAV, or drone)
   - Sensors from Landsat, SENTINEL and SRTM missions.
   - Specific sensors for drones
   - Digital image acquisition, pre-processing, processing and classification
   - Relating the physiology of the vine with remote sensing information
   - Case studies of the use of multispectral images captured by drone in viticulture
3. Three-dimensional modelling of the terrain and vegetation
   - Three-dimensional analysis of vegetation and terrain
   - Digital Surface Models (DSM) and Digital Terrain Models (DEM)
   - Point clouds and Digital Elevation Terrain Models (DEM).
   - Photogrammetric processes for point clouds, DSM and DEM generation.
   - SRTM program
   - Geomorphometry applied to viticulture (slope and aspect, hydrography, etc.)
   - Presentation of the programs AGISOFT and PIX4D for processing data obtained by drones
4. Global Navigation Satellite System (GNSS)
   - System components. Operation and practical applications
   - GNSS technology for surveying and navigation
   - Operation of partly or fully autonomous vehicles using GNSS technology

Recommended reading

1. Smith, M. J. , Goodchild, M. F. , Longley, P. A. , 2018. Geospatial Analysis: A Comprehensive Guide to Principles Techniques and Software Tools. The Winchelsea Press; 6th Edition
2. Lillesand, T. M. , Kiefer, R. W. 2015. Remote Sensing and Image Interpretation, 7th Edition, John Wiley and sons. New York.
3. Aronoff, S. , 1989. Geographic information systems: A management perspective. WDL Publications, Ottawa, Canada.
4. Longley, P. , Goodchild, M. , Maguire, D. , Rhind, D. , 2005. Geographical Information Systems
5. Maguire, D. J. , Goodchild, M. F. , Rhind, D. W. 1991. Geographical Information Systems. Longman Scientific & Technical, New York.

Teaching and learning methods

Four-hour lectures with labs integrated in a computer laboratory. Theoretical introduction during about 20 minutes followed by practical applicatons using tutorial

Teaching and learning methods

models and supervision from the instructor. Some of the classes outdoors.

Assessment methods

1. Regular - (Regular, Student Worker) (Final)
   - Practical Work - 50% (Evaluation of technical reports, practice tests and portfolio (3 ECTS))
   - Final Written Exam - 50% (Final written examination (3 ECTS))
2. Non-regular - (Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100% (Theory and practice written exam (6 ECTS))
3. Special - Finalists and Workers - (Student Worker) (Special)
   - Final Written Exam - 100% (Theory and practice written exam (6 ECTS))
4. Supplementary - (Regular, Student Worker) (Supplementary)
   - Final Written Exam - 100% (Theory and practice written exam (6 ECTS))

Language of instruction

1. Portuguese
2. Portuguese, with additional English support for foreign students.

Electronic validation

João Paulo Miranda Castro	José Manuel Correia Santos Ferreira Castro	António Castro Ribeiro	Maria Sameiro Ferreira Patrício
02-02-2024	03-02-2024	03-02-2024	05-02-2024