COURSE OF STUDY Master's Degree in Innovation Development in Agrifood Systems

ACADEMIC YEAR 2023-2024

ACADEMIC SUBJECT Mechanization and monitoring of cropping systems (Module of I.C. Sustainable field cropping systems for bio-based sectors and bioenergy – 9 ECTS)

General information	
Year of the course	IInd year
Academic calendar (starting and ending date)	First semester (from September 25, 2023 to January 19, 2024)
Credits (CFU/ETCS):	3
SSD	AGR09
Language	English
Mode of attendance	optional

Professor/ Lecturer	
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Department and address	Dept. of Soil, Plant and Food Science
Virtual room	7bxi8y9
Office Hours (and modalities: e.g., by appointment, on line, etc.)	Every Friday 10.30 – 12.30 according to an established appointment requested by phone or e-mail. Tutoring could be also on e-learning platforms

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
75	*16*	*14*	*45*
CFU/ETCS			
3	*2*	*1*	

Learning Objectives	The teaching, with an application slant, aims to provide knowledge relating to the main technologies used in precision agriculture or smart farming and agriculture 4.0. In particular, the following concepts will be deepened: a) the management of spatial and temporal variability of soil and crops; b) remote sensing and proximal sensing using suitable sensors; c) satellite positioning and guidance systems applied to agricultural machinery; d) remotely piloted aerial and robotic platforms for crop monitoring and management; e) the variable rate technology; f) the use of ad hoc software for processing images captured by drones.
Course prerequisites	Mathematics, Physics and Agricultural Mechanics and Mechanizations (propaedeutic).

Teaching strategie	The topics of the course will be treated with the help of Power Point presentations. All students will be able to receive a copy of the Power Point presentations

	used during lectures.
Expected learning outcomes in terms of	The expected results concern the acquisition of key concepts relating to the main digital technologies used in the field of precision agriculture and 4.0.
Knowledge and understanding on:	○ Advanced knowledge and understanding of the fundamental concepts of precision agriculture, with particular reference to remote sensing and proximal sensing. ○ Knowledge and understanding of global positioning systems, semi-automatic and automatic steering systems of agricultural tractors. ○ Knowledge and understanding of variable rate technology. ○ Knowledge and understanding of remotely piloted aerial and ground robotic platforms for crop monitoring and management.
Applying knowledge and understanding on:	○ Ability to recognize and manage the machines to be used in precision agriculture and 4.0. ○ Ability to critically analyze the technical-functional characteristics and the choice of machines and remotely piloted aerial and terrestrial robotic platforms. ○ Ability to use remotely piloted aerial platforms (drones) and to process the images captured by cameras mounted on board the drones by using dedicated software.
Soft skills	• *Making informed judgments and choices* ○ Ability to evaluate and choose the typical technologies of precision agriculture and 4.0 and their inclusion in the various business contexts, respecting the environment and the health of the operators. • *Communicating knowledge and understanding* ○ Ability to expose and argue on complex issues of precision agriculture and 4.0 both in written and oral form. ○ Communication and reporting skills within a multidisciplinary working group and ability to judge technical, economic, human and ethical issues. • *Capacities to continue learning* ○ Ability to learn through the development of cognitive tools and logical elements related to the applied engineering sector for precision agriculture and 4.0. ○ Ability to use the tools and new IT technologies that ensure a continuous updating of knowledge in the specific professional field and in the field of scientific research.
Syllabus	
Content knowledge	**Introduction to precision mechanization**. Definition and evolution of precision agriculture **Remote sensing.** Physical and technological principles of remote sensing. Electromagnetic radiation. Remote sensing in the optical domain. The Lidar. Remote sensing carrried out within the thermal infrared. Vegetation monitoring in the optical domain. NDVI index. Thermal infrared vegetation monitoring. **Remotely piloted aircraft systems.** Typologies. Visible, multispectral and hyperspectral sensors. Thermal sensor. Lidar. **Processing of images captured by drones.** Use of Pix4DMapper software.

	Satellite Positioning Systems (GNSS). The satellite constellations: Glonass, Galileo, Compass, Navstar-GPS. How GNSS works. Causes of signal error. Signal properties and types of correction. GPS in agriculture. Criteria for choosing a GNSS. **Driving systems applied to agricultural machines.** Operating modes and types: assisted driving, semi-automatic driving, automatic driving. Navigation systems without GNSS. Automations via ISOBUS protocol. **Yield mapping systems.** Cereals yield mapping. Sensors in the combine. **Sensors and methods for proximal measurements.** Geophysical proximal sensors. Sensors for microclimate and plant monitoring. Soil moisture sensors.
Texts and readings	• H.J. Heege - «Precision in Crop Farming» –Edited by Springer, United Kingdom, 2013 • R. Casa - «Agricoltura di Precisione». Edagricole, Milano, 2016 • Pix4Dmapper 4.1 User Manual
Notes, additional materials	
Repository	Course participants will have the opportunity to use the Pix4dMapper software. The teaching material (Power Point and Pix4DMapper Manual) will be available on Teams.

Assessment	
Assessment methods	The exam consists of an oral test on the topics developed during the lectures hours. A minimum of 4 questions will be asked on different topics within the aforementioned program. For students enrolled in the year of the course in which the teaching is carried out, an in itinere test will be held which will take place in the period from November 13, 2023 to November 24, 2023. This in itinere test consists of an oral exam on the topics developed during the hours of the course carried out up to the date of the intermediate test itself. The outcome of this test contributes to the assessment of the profit exam and is valid for one academic year. The assessment of the student's preparation is expressed with a vote out of thirty. The intermediate test is passed with a vote of at least 18/30.
Assessment criteria	• *Knowledge and understanding* ○ The knowledge and ability to understand the concepts illustrated during the course will constitute the elements for the basic assessment of the student. • *Applying knowledge and understanding* ○ A further element of evaluation will be the ability to understand from an application point the methods and technologies inherent the precision agriculture and 4.0 analyzed during the course. • *Autonomy of judgment* ○ The ability to choose the technologies for precision agriculture present on

	the market and their use in the various company contexts, respecting the environment and the health of the operators will constitute another essential element of evaluation. • *Communicating knowledge and understanding* It will constitute element of evaluation: ○ Knowing how to present and argue on complex issues of precision agriculture and 4.0 both in written and oral form. ○ Knowing how to relate within a multidisciplinary work team. ○ Ability to organize the acquired knowledge in the form of presentation and discourse articulation for didactic-training purposes. • *Capacities to continue learning* Finally, it will constitute an element of evaluation: ○ Knowing how to learn information from regulations and reference texts in the sector of technologies used in precision agriculture and 4.0. ○ Knowing how to use the tools and new information technologies that guarantee continuous updating of knowledge in the specific professional sector and in the field of scientific research.
Final exam and grading criteria	The evaluation of the students' achievement will be expressed with a mark out of thirty. The exam is passed with a score of at least 18/30. In the case of maximum marks (30/30), honours can be attributed.
Further information	
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