UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Scienze Agrarie, Alimentari e Forestali
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	PRECISION AGRICULTURE
SUBJECT	IRRIGATION SYSTEMS WITH SENSORS AND INTELLIGENT TECHNOLOGIES
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50546-Discipline della ingegneria agraria
CODE	22911
SCIENTIFIC SECTOR(S)	AGR/08
HEAD PROFESSOR(S)	AUTOVINO DARIO Ricercatore a tempo determinato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	90
COURSE ACTIVITY (Hrs)	60
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**AUTOVINO DARIO** Wednesday 11:00 13:00 Si riceve per appuntamento. Viale delle scienze Ed. 4, Ingresso - E, Piano - primo, Studio - 129 Thursday 11:00 13:00 Si riceve per appuntamento. Viale delle scienze Ed. 4, Ingresso - E, Piano - primo, Studio - 129

DOCENTE: Prof. DARIO AUTOVINO

PREREQUISITES	To understand the contents and achieve the learning objectives of the course, the student must have acquired the basic concepts of physics and agricultural hydraulics that are commonly given by the bachelor degree courses of class L25
LEARNING OUTCOMES	Knowledge and understanding Know the farm irrigation methods under pressure and irrigation machines. Knowing how to define the most appropriate irrigation method in relation to the site-specific characteristics of the soil-plant-atmosphere system (SPA) and the peculiarities of the pedo-cultural context. Know the systems and technologies available for smart irrigation management. Knowing how to understand and quantitatively analyze the terms of water/energy efficiency at the scale of the SPA system and at the farm scale. Understand the limitations of measurement sensors with regards to the observation scale effects of the monitored processes, the importance of zoning procedures, as well as the need for sensor calibration and validation. Ability to apply knowledge and understanding Be able to independently design and verify the correct functioning of pressurized irrigation systems. Know how to evaluate the uniformity and efficiency of farm irrigation distribution systems. Being able to propose and evaluate solutions for monitoring and managing water resources at the farm scale. Judgment autonomy Ability to gather data and process them according to methods suitable for assessing the crop water requirements. Acquisition of skills suitable for solving essential technical problems in the design, verification and management of irrigation at farm scale. Communication skills Ability to present problems relating to the design and management of irrigation systems both in technical language and in popular form. Mastery of scientific and technical language and ability to interact with other professionals in group work. Ability to present the learned theoretical and practical knowledges in the form of a written technical-professional report. Learning ability Ability to update through autonomous consultation of scientific publications specific to the sector, especially with reference to methodologies that are the subject of development and research, and through continuing education and/or attendance at specialization courses.
ASSESSMENT METHODS	Final exam consists of an oral discussion on the subjects studied during the course with specific consideration of the practical exercises. The interview will be aimed at ascertaining the possession of the theoretical and practical knowledge required by the course through the discussion of the topics covered by the program and the exercises carried out, in order to verify a) the knowledge acquired, b) the planning and processing skills and the attitude about the technical tools with specific reference to the case studies developed, c) the possession of an adequate property of technical language and presentation skills. A minimum of three questions will be posed to assess student's ability and autonomy in solving practical cases. Grades range from 18 to 30. Minimum mark (18) is reached when student shows a basic knowledge and understanding of course subjects . Below this threshold the exam is not passed. The more the student will show knowledge and understanding of the subjects and autonomy in applying them to practical cases related to professional contest, the higher the mark will be.
EDUCATIONAL OBJECTIVES	The course aims to provide master's degree students with the essential application tools for designing sprinkler and drip irrigation systems and suggest their correct use for sustainable water management. The course also intends to provide the fundamental knowledge for the application of water saving strategies supported by the monitoring of the environmental variables that govern the evapotranspiration processes and, consequently, the water consumption of plants. An integral part of the educational objectives is the preparation, by each student, of a Report which includes the results of the practical applications carried out during the exercises and describes, through a technical report, the results of the case studies developed during the course. In relation to the educational objectives, the assiduous attendance of the Course and exercises is strongly recommended.
TEACHING METHODS	The course is organized with frontal lessons and practical-application exercises carried out weekly, working with Excel worksheets and CAD tools, and concerning the development of case studies aimed at designing an irrigation system for sprinkling (I part) and micro-irrigation (II part) intended for farm irrigation, as well as the preparation of an adequate monitoring system for the parameters of the soil-plant-atmosphere system, which has the objective of

	carrying out irrigation management in conditions of "controlled water deficit". The exercises must be accompanied by technical reports drawn up individually or in groups by the students, which will be corrected by the teacher and discussed during the final exam.
SUGGESTED BIBLIOGRAPHY	Appunti e diapositive presentate nel corso delle lezioni a cura del Docente (file pdf) verranno trasmesse agli studenti dal Docente durante il Corso, con anticipo rispetto alle lezioni svolte. Gli appunti che vengono inviati dal docente possono considerarsi sufficienti per la preparazione all'esame se lo studente frequenta assiduamente le lezioni e svolge con continuità le esercitazioni, interagendo con il docente per la correzione delle medesime. Testi per la consultazione: • Allen R. et al., Crop evapotranspiration – Guidelines for computing crop water requirements. FAO Irrigation and Drainage paper 56 (1998). Rome. ISBN 92-5-104219-5. • Capra A., Scicolone B. Progettazione e gestione degli impianti di irrigazione. Criteri di impiego e valorizzazione delle acque per uso irriguo (II ed.). Editore: Edagricole-New Business Media (2016). ISBN 978-88-506-5494-9. • Piero Santelli. Impianti di irrigazione a goccia per le colture agrarie. Dario Flaccovio Editore (2019). ISBN 9788857909127. Testo di approfondimento F. Lamm, J. Ayars, F. Nakayama: Microirrigation for crop production. Design, Operation and management. Elsevier (2006). ISBN: 9780444506078.

SYLLABUS

Hrs	Frontal teaching
2	Illustration of the course, exercises operating method and exam carrying out. Introduction to the Course: Irrigation as a tool for the qualitative and quantitative improvement of agricultural production. Notes on the sources of water supply for irrigation. Aims and organization of irrigation. Pressurized irrigation methods: sprinkler and drip irrigation systems.
8	Review of hydraulics of pressurized currents. Continuous and localized pressure drops. Application of the flow equation and continuity equation. Power of a pump and evaluation of energy consumption. Review of agricultural hydrology: hydrostatics and hydrodynamics of water in the soil and in the plant. Water-soil-plant relationships. Analysis of water exchanges with the atmosphere.
6	Sprinkler irrigation: Advantages and disadvantages of the method. Choice of sprinkler irrigators as a function of operating pressure; sprinklers arrangement on the ground and assessment of distribution uniformity. Duration of watering and irrigation efficiency. Determination of the soil physical characteristics aimed at choosing the intensity of rainfall. Criteria for the design of a sprinkler irrigation system. Mechanized sprinkling irrigation: pivot, translating wing, rolling wing, self-propelled sprinkler. Evaluation of energy consumption for sprinkling systems.
6	Drip irrigation: system components, emitters arrangement, types of emitters. Flow rate-pressure head relationship. Water distribution uniformity. Design of a drip irrigation system. Water filtration. Technical characteristics of water filtration systems. Fertigation systems. Criteria for the design of a drip irrigation system.
8	The soil-plant-atmosphere continuous system. Irrigation scheduling for water sustainable management through the identification of irrigation time and water supply which takes into account the characteristics of the soil, the climate and the cultivation parameters. The FAO-56 model. Calculation of the readily available water fraction and of the effective evapotranspiration. Criteria for choosing the irrigation threshold and the optimal threshold. Choice of thresholds in conditions of limited water resources. Precision irrigation. Irrigation management strategies in conditions of controlled water deficit. Implementation of controlled deficit irrigation by irrigation scheduling.
6	Decision support systems. Smart technologies based on meteorological data, on soil monitoring (water content and/or matrix potential), on plant monitoring (xylem potential, sap flows) and on water balance simulation models in the soil-plant-atmosphere system. Combined use of models and sensors. Automation of hydraulic actuators. Overview of wireless sensor networks (WSN). Expert retroactively controlled and/or forecast-based irrigation management protocols. Accuracy of the measured and/or estimated data. Sensor calibration protocols. Calibration and validation of agro-hydrological models.

Hrs	Practice
8	Design of a sprinkler irrigation system and related hydraulic sizing.
8	Design of a microirrigation system and related hydraulic sizing.
6	Design of a decision support system based on the state variables monitoring(water content and potential) and on the water flows in the soil-plant-atmosphere system.