



Agricultural University of Athens
School of Environmental and Agricultural
Engineering

STUDY GUIDE
2023-24

Annex M2.3



Study Guide

The Unidepartmental Postgraduate Program
Digital Technologies and Smart Infrastructures in Georgia

(ιστοσελίδα <http://smartag.aua.gr/>)

Athens

September 2023

Welcome

Dear students,

It is a great honor and pleasure for me to welcome you to the new postgraduate program entitled "Digital Technologies and Smart Infrastructures in Agriculture". This program reflects our commitment and commitment to fostering innovation and exceptional academic quality.

With a modern and dynamic curriculum, we seek to train scientists who will have the knowledge and skills to meet the demands of the modern world. This program offers a unique opportunity for deep understanding and application of digital technologies and smart infrastructures in agriculture, with an emphasis on practical experience and research.

The Study Guide is a valuable source of information on the structure and organization of the program, the courses to be taught, as well as the opportunities offered by this new academic discipline.

We wish it to be an academic year full of success, creativity and personal growth for all of you. We will make every effort to ensure that your path in the program is interesting, fruitful and offers knowledge that will benefit you in your professional career.

We welcome new students to this innovative academic adventure and wish everyone a fruitful and productive academic year.

The Director of the MSc

Spyridon Fountas

Professor

Contents

Presentation of the Department of Natural Resources and Agricultural Engineering.....	4
Mission of the MSc.....	6
Learning outcomes.....	6
Career prospects.....	7
Teaching staff of the MSc.....	7
Contact details of the MSc.....	8
Quality Assurance.....	9
Structure of the MSc.....	10
Curriculum.....	13
SEMESTER A (Fall).....	13
B SEMESTER (Spring).....	20
Academic calendar.....	26
Internal Regulation of the Department for the MSc.....	27

Presentation of the Department of Natural Resources and Agricultural Engineering

The Department of Natural Resources and Agricultural Engineering belongs to the newly established School of Environment and Agricultural Engineering. The object of the Undergraduate Program of Studies of the Department of Natural Resources and Agricultural Engineering is "the integrated education and training of scientists as well as the promotion of research in subjects related to the rational use, management and protection of natural resources and the environment in general, as well as the development of research and technology in the fields of Agricultural Engineering and Land Reclamation". The Department awards a single degree in Agronomist (Integrated Master – Level 7 of the National and European Qualifications Framework) specializing in Natural Resources Exploitation and Agricultural Engineering. The Department operates four sections:

- Soil Science and Agricultural Chemistry
- Water Resources
- Agricultural Construction and Agricultural Engineering
- Geological Sciences

Our Department offers an applied curriculum that provides many career opportunities in one of the most stable industries in the world, Agriculture. We believe that our graduates will fill some of the most critical positions required in the coming decades, in an effort to provide appropriate water use in agriculture, particularly for irrigation and drainage, appropriate use of soil including its restoration and protection, appropriate use of natural resources, and risk management of natural and anthropogenic environmental hazards, and appropriate use of engineering systems and infrastructure in agriculture.

Graduates of our department apply their knowledge in agricultural systems, natural resources, and engineering to meet social needs and progress. In addition, they aim to ensure the environmental compatibility of technologies and practices used by Production Agriculture. The curriculum in Natural Resources and Agricultural Engineering offers a wide range, with specialization options in natural resource engineering with a particular focus on water and soil, as well as mechanical systems. The Thematic Areas of the Department also include Technical Uses and Management of Natural Resources with the Help of Computers, Renewable Energy Systems, Sustainability of Natural Resources, and the mechanical properties of biological materials. In addition, research and application of mechanical equipment in Agriculture, design of agricultural facilities, environmental studies and engineering/technical management, determination of physicochemical properties of water and soil, as well as thorough knowledge of the soil-plant-atmosphere system, are all parts of our graduates' arsenal.

Environmental and economic sustainability is key to our future – the Department of Natural Resources and Agricultural Engineering at the Agricultural University of Athens helps prepare our graduates to meet this challenge. At CSR&DM, our graduate learns about ecosystem processes (hydrological cycle, nutrient transformation processes and biological systems), how human activities, such as agriculture, affect these complex systems and how to design sustainable solutions. The graduate will also acquire the background in chemistry and biology necessary to understand the influences of contaminants and pollutants on the environment. Basic engineering principles, as well as newer technological approaches such as geographic

information systems, sensor design, decision support systems in water resources, and soil and water restoration are applied to solve challenges related to all biotic and abiotic environments. Soil mapping, land use planning, soil evaluation systems and models, geographic information systems and remote sensing in natural resources, evaluation and rational use of fertilizers, organic fertilizers and soil improvers, surface and groundwater quality, micrometeorology – bioclimatology, animal environments and food safety are part of our graduates' supplies. All these tasks require modern infrastructure, including the development of water storage, transport and distribution systems for agriculture, drainage, flood, drought and erosion response works, cooling chambers and warehouses for agricultural products, greenhouses, as well as livestock farms, and fish farms. Equipment and agricultural machinery for soil cultivation and crop harvesting, precision agriculture, automation and robotics in agricultural production systems, as well as the creation and control of artificial environments are also included. In addition, the mechanical systems specialization in the Department prepares graduates for competitive careers focused on the systems, processes, and machinery used to produce or use energy, food, and water. Overall, education in the Department of Natural Resources and Agricultural Engineering prepares graduates for exciting careers in national and local administration, in consulting firms, in industry, and offers significant graduate study opportunities.

Mission of the MSc

Objective: The Department of CSR and GM of the Agricultural University of Athens, within the framework of the MSc, aims to provide specialized knowledge and scientific training in modern subjects to support issues related to agricultural and environmental engineering.

It also educates and provides research knowledge at postgraduate level in the disciplines and research interests of the faculty members who serve in it.

Purpose: The purpose of the CSR and GM department, within the framework of the MSc, is:

a) The promotion of scientific knowledge and the development of research and applications on issues related to specializations in the Postgraduate Program and the disciplines served by the Department, namely:

- 1) Renewable Energy Technologies and energy efficiency on farms
- 2) Smart Agricultural Infrastructure (greenhouses, vertical farming systems and livestock installations)
- 3) Post-harvest technologies (conventional conservation, degreening and controlled atmosphere chambers)
- 4) Robotics, Automation Systems and Artificial Intelligence
- 5) Precise input management
- 6) Waste Management
- 7) Supply Chain and Traceability of agricultural products
- 8) Data Analysis

b) The creation of specialized scientists capable of being active at a research level or of responsibly staffing public and private sector services in the field of specialization and thus contributing substantially to the formation of space and sustainable development with scientific criteria.

Learning outcomes

The Postgraduate Studies Program provides important basic knowledge on the principles governing the operation of digital technologies and smart infrastructures through compulsory courses, while at the same time through elective courses it enables further specialization depending on the undergraduate academic level of postgraduate students and their interests.

Career prospects

The knowledge provided by the postgraduate program is essential for today's working conditions where, among other things, specialized studies are required in cases of design, development and management of digital technologies and smart infrastructures.

Teaching staff of the MSc

Department/ Institution	Name	Grade & Employment Relationship (FACULTY, EDIP, EIB or Emeritus, Contract Officer, or other)	Field of study (according to Government Gazette appointment)
CSR&M	ARVANITIS KONSTANTINOS	PROFESSOR, tenured	Automation in Georgia
CSR&M	DERKAS NIKOLAOS	PROFESSOR, tenured	Land Reclamation Management & Irrigation
CSR&M	KARAVITIS CHRISTOS	PROFESSOR, tenured	Water Resources Management
UTH	KATSOULAS NIKOLAOS	PROFESSOR, tenured	Agricultural Constructions - Greenhouses
CSR&M	OICHALIOTIS KONSTANTINOS	PROFESSOR, tenured	Fertility – Soil Biology
CSR&M	PAPADAKIS GEORGE	PROFESSOR, tenured	Renewable Energy Sources: Mechanical Equipment and Agricultural Applications
GFR	SAVVAS DIMITRIOS	PROFESSOR, tenured	Horticultural Crops and Hydroponics
AUA	TRIVELLAS PANAGIOTIS	PROFESSOR, tenured	Management Standards
CSR&M	FOUNTAS SPYRIDON	PROFESSOR, tenured	Precision Agriculture
PA	AGGELIKI BRAWL	ASSOCIATE PROFESSOR	Construction and Operation of greenhouses
CSR&M	MANOLAKOS DIMITRIOS	ASSOCIATE PROFESSOR	Thermal Applications and Energy Saving in Agriculture
CSR&M	BARTZANAS THOMAS	ASSOCIATE PROFESSOR	Greenhouse and Hydroponic Installations

CSR&M	XANTHOPOULOS GEORGE	ASSOCIATE PROFESSOR	Post-harvest and post-harvesting technologies
CSR&M	PANAGAKIS PANAGIOTIS	ASSOCIATE PROFESSOR	ANIMAL HOUSING
NKUA	SARAKIS BRILLIANT	ASSOCIATE PROFESSOR	Broadband Networks
GFR	DATSI GEORGIA	ASSISTANT PROFESSOR	Hydroponics
CSR&M	SOULIS KONSTANTINOS	ASSISTANT PROFESSOR	Soil Chemistry
PAPEL	PEPPAS KONSTANTINOS	ASSISTANT PROFESSOR	Telecommunications
CSR&M	PSOMIADIS EMMANOUIL	ASSISTANT PROFESSOR	Remote Sensing in Geological and Agricultural Sciences
CSR&M	LOUKATOS DIMITRIOS	EDIP	Cyber-Physical Systems and Smart Infrastructure in Georgia
NKUA	ZOULIAS EMMANOUIL	EDIP	Programming
CSR&M	ANESTIS VASSILIOS	SCIENTIFIC PARTNER	Water Resources Management
AUA	KARAVAS CHRISTOS-SPYRIDON	SCIENTIFIC PARTNER	Autonomous Smart Microgrids RES
CERTH	KYRIAKARAKOS GEORGIOS	SCIENTIFIC PARTNER	Autonomous Smart Microgrids RES
NCEFED	MANOLOPOULOS IOANNIS	SCIENTIFIC PARTNER	Computer Engineer, PhD
AUA	DAVU ERIKA	RESEARCH ASSOCIATE	Mechanical Engineer, PhD
CERTH	BALAFOUTIS ATHANASIOS	RESEARCHER	Biofuels
ELGOD	FERENTINOS KONSTANTINOS	RESEARCHER	Computing
PAPEI	MANES KONSTANTINOS	RESEARCHER	Programming
ELGOD	PETINATOS GERASIMOS	RESEARCHER	Precision agriculture with emphasis on agricultural machinery
PSYCTOT HERM	BAKALIS PANTELEIMON	RESEARCH & DEVELOPMENT MANAGER	Mechanical Engineer, PhD
PSYCTOT HERM	GOUNTAS APOSTOLOS	RESEARCH & DEVELOPMENT ENGINEER	Mechanical Engineer

Abbreviations:

EDIP: LABORATORY TEACHING STAFF

AUA: AGRICULTURAL UNIVERSITY OF ATHENS

GFR: DEPARTMENT OF CROP SCIENCE

CSR&DM: DEPARTMENT OF NATURAL RESOURCES DEVELOPMENT AND AGRICULTURAL
ENGINEERING

UTH: UNIVERSITY OF THESSALY

PA: UNIVERSITY OF PATRAS

NKUA: NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS

NCEFED: NATIONAL CENTRE FOR SCIENTIFIC RESEARCH "DEMOKRITOS"

PAPEL: UNIVERSITY OF PELOPONNESE

ELGA: HELLENIC AGRICULTURAL ORGANIZATION "DIMITRA"

CERTH: CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS

PAPEI: UNIVERSITY OF PIRAEUS

Contact details of the MSc

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Quality Assurance

The MSc "Digital Technologies and Smart Infrastructures in Agriculture" implements a policy for quality assurance in the context of its strategic planning.

Specifically:

1. Sets targets for quality assurance
2. Proceed to the rational management of its resources
3. Carries out the annual internal evaluation of his/her curriculum and revises it whenever the need arises
4. Collects, analyzes and utilizes data in the context of its annual internal evaluation and the setting of new quality objectives
5. Attends the teaching, research and administrative work of the MSc
6. Disseminates information related to the activities of the MSc
7. Carries out its external evaluation procedures, in accordance with the standards of the National Authority for Higher Education

The quality policy of the MSc is posted on the website: <http://smartag.aua.gr/internal-rules-of-operation/>

Structure of the MSc

The requirements of the MSc are described:

1. The duration of the full-time Postgraduate Program leading to the acquisition of the Master's Degree is three (3) academic semesters. The first two (2) academic semesters concern the completion of courses and the third academic semester is available for the preparation, writing and presentation of the Postgraduate Thesis, as well as for attending relevant compulsory seminars and lectures.

2. In justified exceptional cases, this time may be extended by one (1) academic semester, following a proposal by the Coordinating Committee or an application by a Postgraduate Student and approval by the Assembly of the Department. If the above maximum time limit is exceeded, without fulfilling the educational obligations for obtaining the postgraduate degree, the M.F. is deleted by a declaratory act of the Assembly.

3. The Assembly of the Department, at the request of the interested Postgraduate Student and the recommendation of the S.E., for fully justified cases, may decide to accept the suspension of his/her studies for up to twelve (12) months. The period of suspension is not counted in the duration of studies.

4. In any case, the total time for obtaining a Master's degree may not exceed six (6) semesters, including the possible twelve-month suspension of studies.

5. The Postgraduate Program is also provided as part-time duration of four (4) semesters.

The distribution of courses in semesters for part-time students is made by decision of the Assembly of the department, following a proposal by the S.E.

For the Master's Degree, students are required to attend the following courses and a series of seminars by specialists coming from other educational institutions of the Public Sector or from the private sector. The selection of the above will be made in accordance with the provisions of Law 4485/2017. In addition, the postgraduate student is required to participate in seminars, lectures, field trips and field work. The total number of ECTS required for the acquisition of the Master's degree amounts to ninety (90) of which thirty (30) ECTS concern courses of the first semester of studies, thirty (30) ECTS courses of the second semester of studies and thirty (30) ECTS for the preparation, writing and presentation of the Postgraduate Diploma Thesis. In order for an elective course to take place, at least three (3) Postgraduate Students are required to have chosen it. It is possible to conduct an elective course with a smaller number of Postgraduate Students, if the instructors can offer it.

The course schedule is as follows:

Semester A courses:	Required/Elective	ECTS
1. [640001] Smart Sensors and Internet of Things	Y	6
2. [640002] Management of Distributed Energy Production and Smart Grids.	E	6

3. [640003] Design, Management and Environmental Control of Greenhouses	E	6
4. [640004] Indoor Environmental Control for Animal Facilities	E	6
5. [640005] Nondestructive Evaluation Techniques for Analysis of Agricultural Products Quality	E	6
6. [640006] Sophisticated and Autonomous Machinery and Vehicles	E	6
7. [640007] Precision inputs management	E	6
8. [640008] Remote sensing in agriculture	E	6
9. [640009] Bio-Energy	E	6
10.[610010] Programming languages for applications	E	6
Semester B courses:		
1. [640012] Embedded and Real-Time Systems	Y	6
2. [640013] Cyber-Physical Systems and Smart Infrastructures	E	6
3. [640014] Computational Intelligence and Machine Learning.	E	6
4. [640015] Optimization of Energy Efficiency Technologies (and Smart Energy Management) in Agricultural Enterprises	E	6
5. [640016] Advanced Technologies in Hydroponics Systems	E	6
6. [640017] Waste management and circular economy systems	E	6
7. [640018] Traceability and Supply Chain Management	E	6
8. [640019] Data aggregation and analysis in precision agriculture	E	6

9. [640011] Τεχνολογίες ηλεκτροπαραγωγής από ΑΠΕ/Electricity and power production from RET.	E	6
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Curriculum

SEMESTER A (Fall)

In the first semester students are taught 1 Compulsory course (6 ECTS) and should choose 4 Elective courses (24 ECTS) according to the table below.

Course Title and Description	Required/Elective	ECTS
1. [640001] Smart Sensors and Internet of Things	Y	6

The course "Smart Sensors and Internet of Things" is designed to allow understanding of Internet of Things (IoT) technologies, with particular emphasis on their applications in agriculture. The course delves into the fundamental principles of IoT, covering a wide range of topics such as transducers, digitization, communication signals, network architectures, security protocols as well as emerging technologies such as edge computing and edge intelligence. Emphasis is placed on practical applications, particularly in the context of agricultural scenarios, incorporating actions such as field experimentation. Throughout the lectures, students will explore the entire spectrum of IoT, from basic theories to cutting-edge applications, thus building a comprehensive background of knowledge needed in the ever-changing professional field.

Upon successful completion of the course, students will be able to:

Understand the basic principles of signal conversion from one form to another, as well as the theory of digitization.

Understand the role of communication signals and the principles necessary for IoT.

Understand packet switching, basic network topologies, as well as OSI and TCP/IP models.

Understand client-server architectures and their role in IoT.

They utilize LPWAN, network security and cloud technologies with emphasis on agricultural applications.

Understand the role played by sensor and actuator networks and their integration techniques into IoT systems.

Understand advanced concepts such as edge computing and edge intelligence in IoT applications.

Explore energy efficiency and communication coverage in IoT systems.

They apply theoretical knowledge in real field conditions, with particular emphasis on agricultural applications, through the development of simple systems of sense, action and networking.

2. [640002] Management of Distributed Energy Production and Smart Grids.	E	6
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The course "Distributed Power Management and Smart Grids" aims to convey the fundamental concepts of distributed energy production and storage technologies, focusing on the

implementation of a smart grid to facilitate the integration of intermittent renewable energy sources. The course covers the analysis of the security, reliability, capability and flexibility of smart grid energy systems. In addition, it provides an introductory understanding of the concepts outlined in the EU Strategic Energy Technology Plan and the EU Energy Market. Students will deal with the examination of advanced technology applications, economic analyses in the energy industry and will acquire technical knowledge using Smart Grid approaches. The course encourages students to apply critical thinking based on knowledge about the principles of energy policy at European level and key issues in the European energy market.

The course focuses on academic achievement, knowledge acquisition and improved understanding of distributed energy resources. Upon successful completion, students of the Master's degree will be able to:

- Understand the existing structure and technical basis of energy systems for the generation, transmission and distribution of electricity, along with their interaction and interdependence.
- Έχουν βαθιά κατανόηση της κατανεμημένης παραγωγής ενέργειας.
- Create a demand/supply matching system.
- Acquire knowledge and skills in the composition and design of energy management systems.
- They are familiar with the architecture and operation of energy management systems.
- Acquire knowledge and skills in the application of computer tools for the integrated design of energy management systems.
- Design and model a smart grid.
- Understand the EU energy market, including its regulatory framework and policy.

3. [640003] Design, Management and Environmental Control of Greenhouses	E	6
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The course "Design, management and control of greenhouse environments" aims to provide fundamental knowledge in the design, management and control of environmental conditions in plant production systems in controlled environments. While the main focus is on greenhouses, the course also covers alternative systems such as vertical farming, plant factories, and displays. The curriculum includes the analysis of basic design studies, aerial environment control systems (ventilation, heating, cooling and shading), integrated pest management techniques and application of automation and robotics. The course introduces optimal control methods using experts and AI systems. In addition, it provides information on sustainability issues related to greenhouse crops.

Upon completion of this course, students will be able to:

- Understand the main design and structural features of greenhouses.
- Υπολογίσουν τον απαιτούμενο εξαερισμό, ψύξη και θέρμανση για θερμοκήπια και να επιλέξουν τα κατάλληλα συστήματα.
- Understand the importance of environmental control systems and their integration into the control of the indoor environment of a greenhouse.
- Become familiar with the main automation and robotics systems used for greenhouses Crops.
- Acquire knowledge of new production systems of controlled environment (e.g. vertical farming systems).
- Understand the main aspects of environmental control for greenhouses.

- Understand the key sustainability issues of Greenhouse Crops.

4. [640004] Indoor Environmental Control for Animal Facilities

E

6

The course "Regulation of an Artificial Environment of Farm Animal Housing Areas" aims to provide a comprehensive understanding of the control of the internal environment of animal facilities. Using psychometric, energy and mass balance equations, the course explores the interactions between installation, animal heat losses, and indoor environment parameters such as temperature, humidity, and air velocity. In addition, it analyzes sensors and automation techniques to support micro-environmental control and refers to technologies to reduce greenhouse gas emissions from animal facilities.

Upon completion of this course, students will be able to:

- Use energy and mass balance equations to describe thermal, vapour and CO₂ exchanges between an animal facility and the external environment.
- Appreciate the importance of thermal insulation and thermal mass of the building.
- Understand the thermal physiology of animals and their reactions under harsh environmental conditions.
- Calculate the required ventilation rates for all four seasons and select the appropriate systems.
- Understand the importance of refrigeration systems and their integration into the control of the internal environment of an animal facility.
- Explain the role of integrated Advanced Sensor Systems/ Actuator / Control to achieve appropriate indoor environmental conditions in animal dwellings.
- Understand the emissions of environmental pollutants from livestock buildings and the main mitigation/adaptation techniques

5. [640005] Nondestructive Evaluation Techniques for Analysis of Agricultural Products Quality

E

6

The course "Non-Destructive Assessment of the Quality of Agricultural Products" delves into the fundamental principles of non-destructive techniques for food quality assessment. These techniques have evolved significantly in recent decades, with advances in material making them applicable to both pre- and post-harvest scenarios. The course aims to analyze the technological aspects, theoretical bases, advantages and limitations of these techniques, while exploring experimental data analysis based on machine learning techniques.

Upon completion of this course, students will be able to:

- Identify non-destructive technologies and understand their potential.
- Επιλέξουν την καταλληλότερη τεχνολογία ή συνδυασμό τεχνολογιών για την αξιολόγηση της ποιότητας των τροφίμων με βάση συγκεκριμένες εφαρμογές.
- Become familiar with the practical use of these technologies and understand their potential limitations.
- Understand the process of obtaining data from non-destructive technologies, including their specific features.
- Become familiar with analyzing data gained from these technologies, with a particular focus on machine learning techniques.

6. [640006] Sophisticated and Autonomous Machinery and Vehicles	E	6
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The course "Advanced and Autonomous Vehicles and Machinery" is designed to facilitate an in-depth understanding of the basic principles governing the operation of sophisticated and autonomous machines and vehicles, with emphasis on their applications in agriculture. The course begins by justifying the rationale for incorporating smarter machines into agricultural practices. It covers a wide range of topics, including understanding electromechanical requirements, automatic control methods and practices, as well as selecting appropriate sensors, actuators, microcontrollers and networking equipment to provide efficient solutions. Particular attention is paid to handling heterogeneous signals in real-time environments and understanding the basics of cyber-physical systems. The course evolves in a way that familiarizes with the basic principles of automatic control, energy efficiency, sustainability, ergonomics and safety in the context of the sophisticated machines it deals with. Through concrete examples and experiential learning, students acquire upgraded knowledge regarding assessment techniques and applications of sophisticated robots in agricultural environments.

Upon successful completion of the course, students will be able to:

- They justify the need for sophisticated and autonomous machinery in agriculture.
- Understand the underlying electromechanical requirements and basic automatic control techniques.
 - Apply instructions for the appropriate selection of sensors, Actuator, microcontrollers and network equipment.
 - They utilize techniques to handle heterogeneous signals in real-time conditions.
 - Understand the key parts needed to operate more complex systems such as cyberphysical.
 - They add intelligence to robotic systems for improved functionality.
 - They emphasize the use of cameras and GPS sensors for adequate navigation in vehicles.
 - They incorporate guidelines for energy efficiency and sustainable operation.
 - They record and evaluate the behavior of complex robotic machines.
 - They address safety and ergonomics issues related to autonomous machines.
 - They are testing various implementations using adaptive experimental agricultural robotic vehicles.
- Engage in practical experimentation with emphasis on agricultural applications.

7. [640007] Precision inputs management	E	6
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The course "Precise Input Management" provides a comprehensive learning of the fundamental principles of precision farming technologies and practices, specifically tailored to the field of crop production. The course deepens the analysis of crop requirements, including important inputs such as irrigation, fertilization, crop protection products, precision farming methods and selective harvesting methods. The main objective is to understand the technological requirements for precision input management and to transfer theoretical knowledge to practical applications in the field. Students will be exposed to a wide range of precision farming practices, including production mapping, precision irrigation, precision fertilization, crop protection, and harvesting techniques.

The course aims to achieve scientifically adequate provision of theoretical and practical knowledge and improved understanding of precision farming technologies and practices for crop production. Upon completion, students of the Master's degree will:

- Know the principles of precision farming practices.
- Προσδιορίζουν τις τεχνολογίες που απαιτούνται για την εφαρμογή πρακτικών γεωργίας ακριβείας.
- They are familiar with the use of precision agriculture in all crop production practices.
- They have become familiar with the application technologies of precision agriculture.

8. [640008] Remote sensing in agriculture	E	6
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The course "Distance Sensing in Agriculture" is designed to present fundamental principles and innovative advances in Remote Sensing technologies and methods, specially adapted for monitoring, management of agricultural production. The course emphasizes the effectiveness and accuracy of Remote Sensing data, combined with spatial tools such as the Global Positioning System and Geographic Information Systems, to facilitate informed decision-making in agriculture (Soil, Water and Plant System), improved land development and environmental protection. Students will explore the applications of Remote Sensing, mainly in satellite and Unmanned Aircraft Systems (UAS), in crop area estimation, in water resources management, in the detection of pests and diseases, in yield evaluation and in the study evaluation of the suitability of land exploitation for agricultural purposes. The structure of the course includes a combination of lectures, practical applications and exercises, using Remote Sensing software and agricultural application systems, mainly free and open source.

This course aims to achieve scientific competence, knowledge acquisition and improved understanding of Remote Sensing advances and technological advances in crop monitoring, management and production. Upon completion, students of the Master's degree will:

- Know the principles of Remote sensing .
- Identify sensors and images needed to implement practices Remote sensing .
- Acquire skills in data acquisition, storage, management and processing Remote sensing .
- Use advanced techniques from different sources and sensors to map and monitor crops.
- Understand digital image processing techniques in resource management in agriculture.
- Understand precision agriculture more deeply with its use Remote sensing and the possibilities it provides for crop management.
- Explore its applications Remote sensing in water, soil, disease and pest management, and resource management of agriculture.

9. [640009] Bio-Energy	E	6
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The course "Bio-energy" offers an integrated exploration of biomass and its conversion into low-carbon energy systems, covering bioenergy, bioheat and biofuels. The course deepens in scientific examinations of raw materials, transformation technologies, scale of industrial production, finished products and applications. In addition, students will gain entry-level knowledge about sustainability concepts, systems thinking and Life Cycle Analysis and their integration into bioenergy systems. The course emphasizes the potential advantages of low-carbon energy in promoting a sustainable economy and society.

Upon completion of this course, students will be able to:

1. Identify potential biomass feedstocks, including energy crops and various feedstocks for different generations of biofuels.
2. Acquire knowledge of existing and emerging biomass-to-energy technologies, including bioenergy, bioheat and biofuels.
3. Develop an understanding of the principles of Life Cycle Analysis.
4. Develop critical thinking about sustainability and resilience, particularly in the context of bioenergy.
5. Apply knowledge to propose possible solutions for energy needs and challenges by incorporating innovative bioenergy technologies.

10. [610010] Programming languages for applications	E	6
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The course "Programming Languages for Applications" focuses on the transmission of techniques for the use of modern programming languages in application development, with particular emphasis on applications in the agricultural world. The course covers a wide range of topics, starting from problem analysis and algorithm representation, moving on to fundamental programming languages such as C, C++, Python and Java. In addition, the course explains the use of basic Linux commands and scripts, visual programming environments as well as the interface between different command modules. Particular attention is paid to the use of tablets, smartphones and microcontrollers to create programming applications, especially in the context of agricultural scenarios. Through a combination of understanding theoretical concepts and practical application, students will develop a flexible set of skills in topical programming languages with the ability to create applications tailored to the needs of the real world.

Upon successful completion of the course, students will be able to:

- Analyze problems and effectively represent algorithms.
- Proficiently utilize languages and commands in C, C++ environments, Python and Java .
- Understand and apply basic programming principles.
- They use commands Linux and plan scenarios for process analysis.
- They use visual programming environments to develop applications.
- They apply interface techniques between different command modules.
- Develop programming applications for tablet , smartphone and Microcontrollers .
- Apply programming concepts effectively in agricultural application scenarios in the field.

B SEMESTER (Spring)

In the second semester, students teach 1 Compulsory course (6 ECTS) and should choose 4 Elective courses (24 ECTS) according to the table below.

Course Title and Description	Required/Elective	ECTS
1. [640012] Embedded and Real-Time Systems	Y	6
<p>The course on "Embedded and Real Time Systems" focuses on the transmission of fundamental knowledge about embedded systems with emphasis on their applications in agriculture. Covering topics such as analog and digital electronic circuits, microcontroller architectures, Arduino and Raspberry Pi boards, programming languages (mainly C and Python), operating systems, interrupt signal handling, synchronization and performance evaluation. The course equips students with essential skills for developing, experimenting, and implementing embedded systems in real-world conditions. In addition, it explores the use of tablet and smartphone devices and emphasizes practical uses in agriculture.</p> <p>Upon completion of this course, students will be able to:</p> <ul style="list-style-type: none"> • Understand the basic principles of digital and analog circuits. • Understand the architecture and functions of microcontrollers και του ρόλου τους στα ενσωματωμένα συστήματα. • They use the boards Arduino and Raspberry Pi για ανάπτυξη και εκμάθηση εφαρμογών. • They program embedded systems using common languages such as C and Python . • They leverage operating system capabilities tailored for embedded environments with real-time response. • They manage asynchronous events, e.g., through stop signals. • They implement synchronization and parallel management of processes performed by embedded systems. • Utilize tablet and smartphone for fuller human interaction with embedded devices. • Apply techniques for measuring and evaluating the performance and effectiveness of a complex system. • Deal with field applications with emphasis on agricultural applications. 		
2. [640013] Cyber-Physical Systems and Smart Infrastructures	E	6
<p>The course on "Cyber Physical Systems and Intelligent Infrastructures" is designed to facilitate understanding of the fundamental principles of cyber-physical systems, with emphasis on their applications in agriculture. The course covers topics such as the analysis of the structural parts of a cyber-physical system, the selection of appropriate components, the adaptation of automatic control principles to cyber-physics, the mechanisms of response to signals from the physical world, the effective handling of heterogeneous events, parallel processing, communication between different computational processes, the integration of machine learning, the evaluation of the performance of a cyber-physical system and related security issues. Emphasis is placed on experimenting with real cyber-physical systems of agricultural interest.</p>		

Upon completion of this course, students will be able to:

- Identify the role and building blocks of cyberphysical Systems.
- Choose suitable sensors, Actuators , Microcontrollers and network entities to compose a simple cyberphysical system.
- Understand and adapt basic principles of automatic control in the context of a cyberphysics System.
- They develop mechanisms to monitor and adequately respond to signals coming from the natural world.
- They effectively manage synchronous and asynchronous events with different priority.
- They apply parallel processing techniques.
- They integrate intelligent machine learning functions into the underlying system to achieve more autonomous behavior.
- Evaluate the performance of cyberphysical Systems.
- Address the safety and ergonomics issues associated with a cyberphysical system.
- They apply the principles of cyberphysical systems on experimental agricultural robots.
- They conduct practical experiments to highlight the applications of cyberphysical systems in agriculture.

3. [640014] Computational Intelligence and Machine Learning.

E

6

The course entitled "Computational Intelligence and Machine Learning" aims to provide fundamental knowledge and cultivate skills on computational intelligence and machine learning, with emphasis on applications in agriculture. The course covers topics such as mathematical optimization techniques, algorithm complexity, expert systems, decision trees, graph theory, biomimetic optimization algorithms, fuzzy logic, neural networks, hybrid computational intelligence. At the same time, practical examples are explained using widespread platforms and tools. The lectures are designed to equip students with the required knowledge and skills to apply these innovative techniques within agricultural systems.

Upon completion of this course, students will be able to:

- Κατανοούν τις έννοιες της τεχνητής νοημοσύνης, της υπολογιστικής νοημοσύνης και της μηχανικής μάθησης.
- They apply mathematical optimization techniques, including linear programming.
- Analyze the complexity of problems and algorithms required to achieve the necessary computational intelligence.
- Σχεδιάζουν και εφαρμόζουν εξειδικευμένες μεθόδους, όπως δέντρα αποφάσεων, για γεωργικές εφαρμογές.
- Use adequately Graphs to solve optimization issues.
- Apply biomimetics optimization algorithms and understand their applications.
- They apply evolutionary computation techniques to problem solving.
- They apply fuzzy logic as a solution to artificial intelligence problems.
- Understand the fundamental principles and examples of their application Neural Networks.
- They apply hybrid computational intelligence techniques.
- Work using widespread platforms and tools for machine learning.
- They conduct experiments emphasizing the applications of machine learning in agriculture.

4. [640015] Optimization of Energy Efficiency Technologies (and Smart Energy Management) in Agricultural Enterprises	E	6
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The course "Energy Efficiency Optimization (and Smart Energy Management) in Farms" is designed to present cutting-edge technologies, strategies and best practices aimed at improving energy efficiency in agribusiness. The primary objective is to ensure sustainable development and increase the competitiveness of agricultural products. The course will thoroughly examine aspects of energy efficiency in three main pillars of agricultural production systems:

- Open field agriculture: Arable crops, vegetables, Plantations Vineyards.
- Greenhouses: plastic material, glass.
- Livestock establishments: pig farming, poultry farming, cattle breeding .

Upon completion of this module, participants will be able to:

- Acquire knowledge about the energy requirements and challenges of open agriculture, greenhouses and livestock facilities.
- Become familiar with cutting-edge technologies designed to improve energy efficiency in agribusiness.
- Learn and apply industry best practices to optimize energy use in various agricultural environments.
- Κατανοήσουν πώς η βελτιωμένη ενεργειακή απόδοση συμβάλλει στη συνολική βιωσιμότητα των γεωργικών επιχειρήσεων.
- Analyze the impact of energy efficiency on the competitiveness of agricultural products in the market.

5. [640016] Advanced Technologies in Hydroponics Systems	E	6
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The course "Advanced Technologies in Hydroponic Crop Systems" aims to provide fundamental knowledge in the management and control of greenhouse hydroponics systems. The curriculum includes the analysis of how to study the design of hydroponic systems, the systems of a hydroponic system and their use for the production of greenhouse crops. The course introduces optimal control methods using specialists and AI systems. In addition, it provides information on the preparation and use of nutrient solutions in hydroponics systems.

Upon completion of this course, students will be able to:

- Understand the main design and structural features of Hydroponic Systems.
- They design different substrates and Hydroponic system.
- Know the basic components of open and closed Hydroponic συστημάτων.
- They create nutrient solutions using salts or mixed fertilizers.
- Choose a one's hardware and ICT components Hydroponic System.
- Implement control strategies Hydroponic Systems
- They calculate the required ventilation, cooling and heating for greenhouses and select the appropriate systems.

6. [640017] Waste management and circular economy systems	E	6
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This course focuses on the science, engineering and policy behind sustainable waste practices. Topics include sustainable water management, wastewater management (including water reuse.)

The aim of the course is for students to become familiar with and get to know well sustainable concepts and plans for waste management. Emphasis is placed on examining the technical, environmental, economic and social aspects of these concepts. Upon completion of this course, students will be:

- Knowledge of multiple technologies and concepts for sustainable waste management.
- Competent in applying methodologies for the development of sustainable waste management alternatives.
- σε θέση να προσδιορίσουν περιβαλλοντικά, κοινωνικά και οικονομικά ζητήματα που σχετίζονται με διάφορες δυνατότητες διαχείρισης αποβλήτων .
- able to implement issues sustainability (environmental, social and economic) including multicriteria decision analysis tools (MCDA) to provide suggestions for the most appropriate options to address problems.

7. [640018] Traceability and Supply Chain Management	E	6
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The course "Traceability and Supply Chain Management" provides a comprehensive understanding of the fundamentals of retail logistics within fresh food supply chains, with a particular focus on traceability systems. Emphasis is placed on the critical role of traceability in ensuring food safety and optimising business performance. The course covers techniques for building traceability systems, including information modeling and processing, and explores modern traceability technologies such as DNA markers, farm animal e-tagging and various data transfer technologies such as barcoding, RFID and EPC.

Upon completion of this course, graduate students will be able to:

- Understand the structure and dynamics of fresh food retail supply chains.
- Obtain information on legislation on traceability, with emphasis on the requirements of Regulation 178/2002 for all foods and specific foods.
- Acquire the skills to build or adapt traceability systems to meet specific requirements.
- Show πώς η αναγνώριση προϊόντος και η διαχείριση πληροφοριών συμβάλλουν στην αποτελεσματική ιχνηλασιμότητα.

8. [640019] Data aggregation and analysis in precision agriculture	E	6
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The course "Fusion and Information Analysis in Precision Agriculture" is designed to provide students with a comprehensive understanding of the basic knowledge, methods and tools for gathering and analyzing vast amounts of qualitative and quantitative spatial data in precision agriculture. With a focus on monitoring technologies, students will explore data collection materials, including remote and near remote sensing, agricultural drones, ground sensors, global navigation satellite systems, performance monitoring devices, and weather stations. The course emphasizes geoinformatics, geographic information systems, spatial analysis, spatial statistics and geostatistics as key elements for managing spatial variability.

Upon completion of this course, students will have the ability to:

- They use the Geoinformatics in precision agriculture. They will understand and apply the Geoinformatics στη γεωργία ακριβείας για τη διαχείριση των καλλιεργειών, την αξιολόγηση των υδάτινων πόρων και των πόρων της γης και την περιβαλλοντική παρακολούθηση.
- Know what basic techniques geospatial analysis, including vector and raster functions, to explore, explain and interpret spatial data.

- Become familiar with GIS technologies and tools for analysis, distribution and Visualization geospatial δεδομένων.
- Understand spatial statistics and geostatistics necessary for precision agriculture.
- Learn techniques Modeling χωρικών δεδομένων και ανάλυσης παλινδρόμησης για αποτελεσματική ερμηνεία δεδομένων.

9. [640011] Τεχνολογίες ηλεκτροπαραγωγής από ΑΠΕ/Electricity and power production from RET.

E

6

The course on "RES Power Generation Technologies" aims to convey the fundamental principles of power generation technologies using renewable energy sources. It covers the design principles of such systems, addressing the challenges of integrating renewables into distribution and transmission networks, while ensuring secure, efficient and economical grids. The course thoroughly explores renewable sources and technologies, such as solar energy, photovoltaics, wind, hydropower, geothermal, biomass, wave and tidal energy, smart grids, microgrids and electricity storage. In addition, it provides information on sustainability concepts, systems thinking, Life Cycle Assessment (LCA) and their integration into renewable energy systems.

Upon completion of this course, students will be able to:

- Identify renewable energy sources and assess their potential.
- Understand existing and emerging renewable energy technologies for electricity generation.
- Analyze data and configurations of renewable energy generation, storage, distribution and transmission networks for renewable energy systems.
- Understand the needs of the EU grid and understand the challenges in developing and operating renewable energy systems.
- Acquire comprehensive knowledge of Life Cycle Assessment and its applications.
- Develop critical thinking about sustainability and resilience.
- Identify possible solutions to energy needs and problems by integrating renewable energy technologies for electricity generation.

Academic calendar

1. The academic year shall begin on 1 September of each year and end on 31 August of the following year.
2. Classes and examinations are suspended on the following dates: A) Winter semester: October 28th, November 17th, during Christmas holidays and January 30th (Feast of Letters-Three Hierarchs). B) Spring semester: Green Monday, March 25th, during the Easter holidays that begin on Holy Monday and end on the Sunday of Thomas, May Day and the Feast of the Holy Spirit, the day of the rectorate and student elections. Classes are also suspended on the Friday preceding and Monday following national elections (parliamentary, European elections and local government). In any case, students must be informed about the announcements of the Secretariat of the Department and follow them.
3. Termination of the educational work and the operation of the Department or the University in general, beyond what is provided for by law, is possible by decision of the Senate and only in exceptional cases.
4. The educational work of each SA is structured in two semesters, winter (XE) and spring (EE). The IS starts in the second half of September and the EU ends in the first half of June. The exact dates are determined by the Senate.
5. Each semester includes at least thirteen (13) weeks for teaching and three (3) for examinations. In cases of loss of teaching hours due to emergencies, the instructor takes care of their replacement.
6. Extension of the duration of the semester is allowed only in exceptional cases in order to complete the required minimum number of teaching weeks. The extension may not exceed two weeks and is carried out by decision of the Rector, following a proposal by the Deanship of the Faculty.
7. The examinations shall be held exclusively after the end of the IS and the EU for the subjects taught in those semesters, respectively. The student can be examined in the courses of both semesters in the September examination period. The examination periods are three: 1) January-February, 2) June and 3) the repeat September and last three (3) weeks each.
8. The exact dates of the examinations, the duration, as well as any subsequent modification thereof, for serious reasons, are decided by the Senate. The Assembly of the Department specifies the examination schedule, specifying the total duration of the examinations, the examination date of each course and the venue.
9. The examination schedule is published by the Secretariat of the Department at least one (1) month before the beginning of the examination.