COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Agricultural Sciences		
ACADEMIC UNIT	Biosystems & Agricultural Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	BAE_708	**SEMESTER**	7th
COURSE TITLE	MEASUREMENT SYSTEMS AND SENSORS IN AGRICULTURE		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g., lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	
Tutorials	2	
Laboratory	0	
TOTAL	**5**	**5**
Add rows if necessary. The organization of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialized general knowledge, skills development*	Specialized general knowledge
PREREQUISITE COURSES:	There are no prerequisite courses.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	In Greek and in English for Erasmus students
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

Modern measurement systems have to encounter the everincreasing number of parameters to be measured, as well as the requirement for continuously quality and accuracy improvement. The objective of the course is the thorough examination of the theory and the practice of physical parameters measurement and sensors. In order to achieve that, the basic theory of measurements is combined with sensors technology and electric, electronic circuit theory and applications, as well as with display and recording devices technology, data acquisition and processing systems.

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

1. understand the basic principles of measurement systems and sensors,
2. understand the operations and the needfulness of passive and active circuits for conditioning and matching of sensors' signals,

3. understand the operation and the indispensability of analog-to-digital and digital-to-analog signal converters,
4. understand the operating principles and the fabrication technology of several sensors for measuring physical parameters such as temperature, displacement, proximity, velocity, acceleration, strain, force, weight, volume, liquid-level, pressure,
5. experiment with applications of several modern sensors,
6. know basic methods and systems for displaying and recording measurement data, measurement transmission systems, sample and hold circuits, as well as multiplexing systems for measurement data,
7. handle interface methods and standards between measurement and computing systems, analog and digital I/O boards, as well as software tools for measurement data acquisition and processing,

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

In general, upon completion of this course the student will have further developed the following general skills (from the list above):

Search, analysis and synthesis of data and information, using the necessary technologies
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Respect for the natural environment
Exercise criticism and self-criticism

(3) SYLLABUS

The course involves study of:

1. Introduction to sensors, introduction to measurement and control systems, sensors and their applications, use of sensors in measurement and control systems, measurement systems, openand close-loop control systems, mean value and standard deviation of measurements, measurements distribution.
2. Sensor and measurement systems principles and characteristics: operating range, accuracy, types of error, linearity, sensitivity, resolution, hysteresis, repeatability, dead zone, response, drift, time of operation, reliability, stability.
3. Signal conditioning and matching with passive circuit techniques: signal conditioning and matching basics, signal conditioning with potentiometer and Wheatstone bridge, matching for maximum output voltage, matching for maximum load power, maximum load power through transformer.
4. Signal conditioning and matching with active circuit techniques I: active circuits, operational amplifier, ideal operational amplifier, inverting and non-inverting amplifier, isolator, adder, difference amplifier, instrumental amplifier.
5. Signal conditioning and matching with active circuit techniques II: integrator, differentiator, current to voltage and voltage to current converters, voltage comparator, analog-to-digital (A/D) and digital-to-analog (D/A) signal converters.

6. Temperature measurement: liquid-in-glass and liquid-in-metal thermometers, bimetallic strip, bimetallic thermometer and thermostat, electrical resistance thermometer, thermistor, Seebeck effect, thermocouple, radiation thermometers, pyrometers.
7. Motion parameters measurement I: motion parameters measurement basics, displacement measurement instruments, linear potentiometer, linear variable differential transformer (LVDT), variable area capacitor, measurement and sensors for linear and rotary displacement (rotating potentiometer, absolute optical decoder, incremental optical decoder, absolute optical decoder).
8. Motion parameters measurement II: DC and AC tachometers, proximity sensors (microswitches, variable magnetic resistance sensor, Hall effect sensor, optical proximity sensors), accelerometers (seismic accelerometer, piezoelectric accelerometer), strain gauge, weight and force sensors.
9. Liquid-level measurement: liquid-level measurement typical methods, mechanical and electrical floater sensor, capacitive probe, conductive probe, ultrasonic level transceiver, air bubble level sensor, level measurement with pressure sensors.
10. Pressure sensors: pressure measurement methods, liquid manometers, Bourdon pipe, elastic pressure sensors, capacitive pressure sensors, piezoelectric pressure sensors, pressure sensors with strain gauges, barometers.
11. Display and recording devices for measurement systems: analog display devices, moving-coil and moving-iron meters, ohmmeter, oscilloscope, digital display devices with light-emitting diodes (LED) and liquid crystal displays (LCD).
12. Measurement data acquisition and processing systems I: basic principles of data acquisition and processing systems, measurement transmission systems, sampling, hold and sampling circuits, multiplexing and multiplexers.
13. Measurement data acquisition and processing systems II: serial and parallel computer interface for measurements systems, direct interface, IEEE and RS232 standards, analog and digital DAQ boards, measurements data acquisition, software tools for data acquisition in industrial environment and production control.
TUTORIALS
Practical study of temperature sensors (thermocouple, thermistor, RTD), practical study of variable linear differential transformer and strain gauge, practical study of analog-to-digital (A/D) and digital-toanalog (D/A) signal converters, practical exercises on the software tool Labview (programming with graphical user interface environment and virtual instruments, DAQ boards).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face deliveries. Laboratory exercises in Physical Chemistry
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of ICT (power point) in Teaching • Use of ICT (power point & MATLAB) in Tutorial Training • Use of ICT in Communication with students (Learning process support through the electronic platform e-class).
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements,*	

Activity	***Semester workload***
Lectures	39
Tutorials	26
Writing short reports of laboratory exercises	13
Final Exams	3

clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. *The student's study hours for each learning activity are given as well as the hours of non directed study according to the principles of the ECTS*	Study hours and preparation for the laboratory exercises and the final examination	44
	Course total	**125**
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple-choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	1. The laboratories participate by 30% in the final grade. In order to be examined in theory, the student must have completed all the laboratories and have been successfully examined in them. 2. The main assessment criteria focus on understanding and correlating the knowledge that students gain from the course with other knowledge. Particular emphasis is placed on whether they have developed the ability to apply this knowledge to crop selection and to assess the impact of these changes on the environment. Emphasis is also placed on demonstrating critical ability and justifying the choices they make in each problem. 3. Evaluation is dynamic. It mainly involves problem solving. is done orally or in writing or with a combination of the two, with or without pre-examination on the basic principles of the course, with or without exculpatory advances and with other test or inventive methods, depending on the composition of the dynamics and the needs of the audience. 4. The above are done in the Greek language. For foreign language students (eg Erasmus students) conducted in English	

(5) LITERATURE

Recommended Literature:

- Βιβλίο [13771]: ΗΛΕΚΤΡΙΚΕΣ ΜΕΤΡΗΣΕΙΣ ΚΑΙ ΑΙΣΘΗΤΗΡΕΣ: ΑΡΧΕΣ ΛΕΙΤΟΥΡΓΙΑΣ ΚΑΙ ΣΧΕΔΙΑΣΜΟΣ ΤΩΝ ΗΛΕΚΤΡΟΝΙΚΩΝ ΣΥΣΤΗΜΑΤΩΝ ΜΕΤΡΗΣΗΣ, ΚΩΣΤΑΣ ΚΑΛΑΪΤΖΑΚΗΣ, ΕΥΤΥΧΗΣ ΚΟΥΤΡΟΥΛΗΣ Λεπτομέρειες
- Βιβλίο [33155982]: LabView για μηχανικούς, 3η Έκδοση, Καλοβρέκτης Κωνσταντίνος Λεπτομέρειες
- Βιβλίο [77106782]: Αισθητήρες Μέτρησης και Ελέγχου, 3η Εκδοση, Καλοβρέκτης Κωνσταντίνος Λεπτομέρειες
- Βιβλίο [14724]: Συστήματα μετρήσεων,Βασικές αρχές, Bentley John P. Λεπτομέρειες
- Βιβλίο [77116322]: Ηλεκτροχημικοί Αισθητήρες και Βιοαισθητήρες, Προδρομίδης Μάμαντος Λεπτομέρειες
- Βιβλίο [18548793]: Αισθητήρες μέτρησης και ελέγχου, Elgar Peter Λεπτομέρειες
- Βιβλίο [68372662]: Ηλεκτρικές Μετρήσεις, Νικόλαος Παπαμάρκος, Ιωάννης Πρατικάκης Λεπτομέρειες
- Βιβλίο [94645619]: Ηλεκτρικές Μετρήσεις, Θεωρία και Ασκήσεις, 2η Έκδοση, Θεοδώρου Νικόλαος Λεπτομέρειες
- Κ. Καλοβρέκτη, Labview για μηχανικούς: Προγραμματισμός συστημάτων DAQ, Εκδόσεις Τζιόλα, 2007.
- W. Nawrocki, Measurement Systems and Sensors, Artech House, 2005.
- J. Fraden, Handbook of modern sensors, Springer, 2004.

- Related academic journals:

1. IEEE Transactions on Instrumentation and Measurements.
2. IEEE Sensor Journal