COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**ECE_ELE860**	**SEMESTER**	**8**
COURSE TITLE	INTERNET OF THINGS		

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	
Seminars / Practice exercises	1	
Laboratory		
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).	4	5

COURSE TYPE *general background, special background, specialised, general knowledge, skills development*	Specialised
PREREQUISITE COURSES:	No. Students are advised to have already attended the courses: Embedded Systems I, Wireless Sensor Networks
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://www.ece.uop.gr/

(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*

The main goal of the course is to introduce students to the basic concepts of systems that are characterized as "Internet of Things" (IoT), basic technologies and their practical design issues. In this context, many different aspects of the systems related to communication, processing, programming, energy, etc. will be presented and analyzed. challenges. At the same time, there will be training in the use of dominant relevant technologies and in the programming of development boards through which students will have the opportunity to focus on practical issues of designing IoT systems.

Keywords: Built-in systems, Wireless communication protocols, Low resources, Dynamic topologies, Wireless sensor networks, Cloud infrastructure

The knowledge and the skills acquired will form the basis for the courses of next semesters like the course CYBERPHYSICAL SYSTEMS, for which the current course is prerequisite.

Learning outcomes

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

<u>At knowledge level:</u>

1. To describe the basic structural components of an IoT system
2. To understand the architecture and the way an IoT system works
3. To know the interfacing capabilities between the constituent components of an IoT system
4. To be able to analyze the performance of an IoT system

<u>At skills' level:</u>

1. Familiarize with the development boards used for IoT system design
2. Be trained in programming end-to-end IoT systems using state-of-the art development boards
3. Be trained in using specialized software for designing/development of IoT systems

<u>At capabilities' level:</u>

1. Select the proper components for designing an IoT solution considering the functional and non-functional requirements
2. To solve practical problems that appear during IoT system design
3. To evaluate the properties, the capabilities and the features of an IoT system
4. To perform holistic analysis and evaluation of end-to-end application specific IoT platforms

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…*
	…….

- Search, analysis and synthesis of data and information using appropriate tools and technology
- Working individually
- Working in group
- Working in international environment
- Promoting free, creative and inductive thinking
- Promoting new research ideas

(3) SYLLABUS

The importance that the IoT paradigm introduced. Familiarize to the IoT technonological ecosystem. Which are the difficulties/challenges/constraints of IoT systems? Comprehension of all the major aspects of designing/developing/operating/maintaining and IoT system. In depth analysis of cloud services and interconnection with IoT ecosystems. Architecture of IoT applications. IoT communication protocols. IoT processing units. Review the IoT architectures taxonomy. IoT driven Operating Systems (OS). Study the role of sensors/actuators in IoT. How the IoT architecture affects its performance. How the IoT architecture affects its energy consumption. IoT communication buses. Programming of IoT devices.

The course lectures cover the following thematic areas:

1. **IoT Fundamental concepts - Application domains** Fundamental concepts, characteristics and application domains of IoT. Why do we use IoT? The challenges in IoT system and application designs.
2. **Models, Architectures and technologies for IoT** Iot Interconnection models. Dominant reference models of IoT platforms. Differentiations of the IoT model compared to the traditional models. Advantages and challenges.
3. **The IoT protocol stack - Application layer protocols** Thorough presentation and study of all the layers of the IoT stack and key differentiations compared to the OSI/ISO and TCP/IP stacks. Introduction to the IoT stack layers and their interconnections.
4. **Embedded systems for constrained devices (1)** Introducing architectures and designs of constrained embedded devices.
5. **Embedded systems for constrained devices (2)** Study of specific prominent architecture from each family of such devices, such as ARM, TI, Intel, focusing on the programming of those devices, their interfaces, I/O and practical applications.
6. **Gateway Architecture, Edge Computing (1)** presentation of and end - to - end IoT architecture, emphasizing on the design of the appropriate gateways towards the realization of edge. Emphasis will be given on communication and integration approaches such as MQTT, RestAPI, CoaP, etc.
7. **Gateway Architecture, Cloud Computing (2)** presentation of and end - to - end IoT architecture, emphasizing on the design of the appropriate cloud infrastructure towards the realization of cloud computing. Emphasis will be given on communication and integration approaches such as MQTT, RestAPI, CoaP, etc.
8. **Communication Protocols for IoT, advantages and disadvantages (1)** Design, development and detailed presentation of the dominant communication/integration protocols that focus on conserving resources, dynamic topologies, extensibility, adaptability and in general elements that are needed in IoT. Emphasis will be given on layers MAC
9. **Communication Protocols for IoT, advantages and disadvantages (2)** Design, development and detailed presentation of the dominant communication/integration protocols that focus on conserving resources, dynamic topologies, extensibility, adaptability and in general elements that are needed in IoT. Emphasis will be given on layers Routing and Transport.
10. **IoT Operating Systems (1)** Detailed presentation and analysis of Operating Systems that focus on IoT devices and focus on optimal resource utilization, task scheduling, preemptive operation, real - time operation, programming, etc. Particular examples will be given such as Cooja, TinyOS, FreeRTOS.
11. **IoT Operating Systems (2)** Detailed presentation and analysis of Operating Systems that focus on IoT devices and focus on optimal resource utilization, task scheduling, preemptive operation, real - time operation, programming, etc. Particular examples will be given such as Cooja, TinyOS, FreeRTOS.
12. **Structure, Characteristics and Interconnection of IoT devices** Presentation of particular dominant platforms that emphasize on issues such as energy storage, interconnection busses SPI, I2C, etc., structure and operation of ADC/DAC, clocks, etc.
13. **IoT case studies (healthcare, smart home, smart cities, precision farming, etc.)** Presentation, analysis and evaluation popular success stories of the IoT paradigm in various application domains from both academia and industry.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face to face in the classroom.
Remote using eclass platform</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>• Slides (ppt) of the presentation of the theoretical part of the course, which will be available from the beginning of semester through e-Class.
• Guidelines for the exercises (one per exercise), which will be available from the beginning of the semester through e-Class.
• Suggested solutions for each exercise will be provided following the completion of each exercise.
• Support of teaching procedure through the e-Class platform (notification of the teaching procedure, distribution of slides, supplementary material, announcements, relative links and literature, provision of test and the final examination)
• Specialized software relevant to the course.</td></tr>
<tr><td>TEACHING METHODS

The manner and methods of teaching are described in detail.

Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, 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</td><td><table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>39</td></tr><tr><td>Practical examples and exercises – focusing on problem solving</td><td>13</td></tr><tr><td>Study of lectures and bibliography</td><td>53</td></tr><tr><td>Project implementation</td><td>20</td></tr><tr><td>Course Total</td><td>125 hours (5 ECTS)</td></tr></table></td></tr>
<tr><td>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.</td><td><u>A. Evaluation of theoretical part:</u>

Final written exam that includes:

1. Solving exercises
2. Multiple choice questions
3. Comparative evaluation of theory elements

<u>B. Evaluation of exercises/projects</u>

Written exams take place throughout the semester and include:
1. Solving exercises
2. Multiple choice questions

<u>Comments:</u>
• The final grade is the weighted result of the grades of theory and assignments. The weights will be defined and the beginning of each semester and they will be announced via e-Class.
• The final exams are in Greek language</td></tr>
</table>

	• The examination process and the evaluation criteria are publicly available to the students through e-Class.

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

1. Δουληγέρης, Χ., Μητρόπουλος, Σ., 2015. Πληροφοριακά συστήματα στο διαδίκτυο. [ηλεκτρ. βιβλ.] Αθήνα: Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών
2. Learning Internet of Things Paperback – January 27, 2015, by Peter Wahe http://choonsiong.com/public/books/Learning%20Internet%20of%20Things.pdf
3. The Internet of Things (IoT): An Overview, White Papers, Internet Society, https://www.internetsociety.org/sites/default/files/ISOC-IoT-Overview-20151014_0.pdf
4. Δασυγένης, Μ., Σούντρης, Δ., 2015. Ενσωματωμένα συστήματα. [ηλεκτρ. βιβλ.] Αθήνα:Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών

- *Related academic journals:*