COURSE OUTLINE

1. GENERAL

SCHOOL	Engineering		
DEPARTMENT	Electrical and Electronics Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**EEE.8-2.3**	**SEMESTER**	8th
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	2	5
Laboratory Exercises	2	
Total	4	
Add rows if needed. The teaching organization and teaching methods used are described in detail in 4.		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	In-depth Discipline Mastery Course (IDMC)
PREREQUISITE COURSES:	No
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eee.uniwa.gr/el/spoudes/pps/ps

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 IoT course aims to introduce students to the concept of the Internet of Things and to show them how strongly it affects their everyday life, as well as the ways that it can affect them in the near future. Some of the technologies introduced in the course are cutting edge concepts that will promote innovative thinking. Based on this knowledge, students will be able to:

1. Identify the modern trends in the scientific field of IoT and analyze how they interconnect with the science of an electrical and electronic engineer.
2. Understand, describe and categorize the basic architectures, communication protocols, and data used in the IoT.
3. Understand, explain, and develop application inside an ecosystem of interconnected things.
4. Identify, compare and substantiate advantages and disadvantages of alternative technological approaches such as the Wireless Sensors Network (WSN).
5. Understand and describe the functionality and the implementations of the «publish/subscribe» architecture used in IoT.

6. Choose the most appropriate mode of operation in IoT rule based systems.
7. Understand privacy, security and data protection concepts. Analyze and implement counter measures to enforce security and prevention
8. Recognize technologies which can support IoT infrastructures, such as cloud computing, Machine Learning (ML), distributed computation, and Blockchain, as well as methods of using these technologies in IoT.
9. Understand and describe the main principles of IoT applications such as: Smart Home, e-Health, Smart Cities, Intelligent Transportation Systems, Smart Farming, Smart Grid, Smart Livestock Farming, autonomous vehicles and drones.
10. Demonstrate specialized troubleshooting skills, adaptation skills to provide innovative solutions, and develop new knowledge in the IoT field.
11. Cooperate with colleagues in order to tackle advanced problems, to critically analyze alternative solutions, and to make decisions regarding IoT implementations.
12. Contribute to business knowledge and best practices inside complex cooperating environments, in order to implement IoT ecosystems where interdisciplinary collaboration is mandatory.

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
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking

1. Search, analysis and synthesis of data and information, using the necessary technologies
2. Autonomous Work
3. Work as a member of a team (Teamwork)
4. Promoting free, creative and inductive thinking

3. SYLLABUS

Theoretical Part

Section 1: Introductory concepts
Initial presentation of the basic concepts used in an "Internet of Things (IoT)" system as well as its definition and the concept of "*thing*". Presentation of architectures used as a reference as well as privacy and protection issues. Introduction to communication protocols as well as privacy and data protection issues.

Section 2: Sensors and Microcontrollers
This section will describe and analyze the sensors used in an IoT system, what they measure and if they need to be calibrated. Sensors found on each Smart Phone or Smart Wearable Device will be studied and design decisions to be considered when designing and implementing an IoT system will be discussed.

Section 3: Communication and Data Protocols
This section will describe all the protocols used in each modern IoT solution for:

- Communication
- Data Collection and Data Management
- Search and Find

In addition, it will be discussed how the engineer can choose one of them, depending on the application he will have to implement. In particular, some basic communication protocols such as MQTT, CoAP, HTTP and more specific protocols and techniques that provide secure communication over IoT such as MQTT over SSL, X.509 Certificate Based Authentication (Two-Way SSL connection) will be introduced. There will also be widespread ways of exchanging information, based on REST and GraphQL interfaces.

Section 4: Wireless Sensor Networks
This section will report on the sensors at the lower level of the architecture and how they can be connected to each other to create a Network of Sensors. The presentation will focus on the Wireless Sensor Networks, which will be defined, their operation will be studied and their differences will be presented with an IoT solution. In addition, design challenges and applications will be covered.

Section 5: IoT Environments, Platforms and Application Development Tools
In this section, IoT application development environments will be presented, with an emphasis on popular platforms such as Kaa, Device Hive, Zetta, OpenIoT, Carriots, ThingsBoard, NodeRed, etc. in an IoT system (Arduino, Beagleboard, Rasberry Pi (RPi), NodeMCU, CHIP, PocketCHIP etc.). Finally, this section will present how to implement IoT systems for specific purposes (eg Smart Home, Smart Farming, etc.), using a widespread open source platform, such as NodeRed or ThingsBoard.

Section 6: Personal Area Networks Technologies
In this section, Personal Area Networks technologies will be presented, and how they can help in status awareness as well as in creating electronic labels. Specifically, Bluetooth, Bluetooth Low energy (BLE), NFC and RFID technologies will be introduced. The identification through them and the function and structure of the labels as well as the electronic product code (EPC) will be discussed. Applications that use these technologies will be studied and examples will be analyzed. Special emphasis will be given to the presentation, the way and the purpose of the intermediate software.

Section 7: Examples of Real IoT Applications
This section will demonstrate and describe the implementation of real IoT applications. Through a real example, the use of IoT protocols such as MQTT will be studied, as well as the use of real IoT devices, in order to deal with a daily problem, such as controlling a power supply via WiFI.

Section 8: Security and Introduction to the Blockchain Algorithm
The issue of Security and Privacy of personal data plays a very important role in an IoT system. For this reason, this section will present the potential security risks and discuss ways to address them. In addition, there will be a discussion of the Blockchain algorithm and its applications focusing on the IoT.

Section 9: Cooperation and Communication of Devices in Smart Environments
In this section, will be presented how an ecosystem of connected "things" can work, through the creation of rules, the operation under a central administrator, their distributed and peer-to-peer operation, and examples will be presented. The use of central brokers, publish/subscribe systems and rule-making platforms will be presented in the context of specific usage scenarios. Data visualization, Dashboards and Alerts will also be covered.

Section 10: Future Trends
In this section, we will present the future directions we lead through the development of the IoT:

- Intelligence and state awareness - device self-awareness (Context self-awareness)
- Internet of Everything Ecosystem
- Social Internet of Things
- Regulatory and ethical issues
- Presentation of the GDPR

Laboratory Part:

The laboratory training of students is done by performing a number of laboratory exercises focused on the main subjects of theoretical teaching. The exercises will focus on the following areas:

1. Introduction to Emerging IoT technologies
2. Available IoT Platforms (PaaS)
3. Introduction to Node-RED
4. Installation of the Node-RED platform
5. Graphic Display Dashboards in Node-RED
6. User Interfaces in Node-RED
7. Basic Nodes and Flows and Flows in Node-RED
8. The Node-RED Programming Model
9. Interface of Node-RED with APIs
10. TCP, MQTT and Websockets protocols in Node-RED

4. TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face,
Distance learning, etc.</td><td>• Face-to-face (main way),
• Distance learning (supplementary way)</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>• Use of slides with multimedia material in the classroom,
• Learning process support through the course website (e-class platform) supplementary material, notes,
• Implementation of an integrated IoT environment in the cloud infrastructure of okeanos.grnet.gr
• Communication with students electronically, through the course website (e-class platform)
• Wiki system for the Course (e-class platform)</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>Teaching is organized into lectures, exercises / work and study.

<table><tr><th>Activity</th><th>Semester Workload</th></tr><tr><td>Lectures</td><td>26</td></tr><tr><td>Study of lecture material and bibliography analysis</td><td>26</td></tr><tr><td>Individual or Group Project preparation and presentation</td><td>39</td></tr><tr><td>Laboratory Exercises</td><td>26</td></tr><tr><td>Study of the material of the Laboratory Exercises and Reports</td><td>13</td></tr><tr><td>Study and preparation for exams</td><td>20</td></tr><tr><td>Course Total</td><td>150</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>The final overall evaluation is completed at the end of the lectures and includes: (a) the mid-term evaluation (individual or group project), (b) the evaluation of the laboratory part of the course, and (c) the final written examination in the taught material. More detail:
• The mid-term evaluation (20%) takes place around the middle of the semester and includes the documentation and presentation of an individual or group work focusing on IoT application implementations.
• The evaluation of the laboratory part (20%) is done after the completion of the laboratory exercises with oral or written final examination in the whole material of the laboratory part.
• The final written examination (60%) takes place in Greek, without notes, in the whole material.</td></tr>
</table>

5. BIBLIOGRAPHY

-Recommended Bibliography :

1. Daniel Kellmereit, Daniel Obodovski, “The Silent Intelligence: The Internet of Things”, DND Ventures LLC; 1st Edition (September 20, 2013).
2. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley; 1st edition (December 9, 2013).
3. Samuel Greengard, “The Internet of Things”, the MIT Press (March 20, 2015).
4. George Loukas, “Cyber-Physical Attacks: A Growing Invisible Threat”, Butterworth-Heinemann- Elsevier 2015.
5. Lecture Material

- Related Scientific Journals:

- IEEE Internet of Things Journal
- ELSEVIER Journal of Network and Computer Applications