COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Postgraduate		
COURSE CODE	**ENE_APP-103**	**SEMESTER**	**1**
COURSE TITLE	MICROCONTROLLERS AND INFORMATION TRANSMISSION		

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	0	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).	3	

COURSE TYPE *general background, special background, specialised, general knowledge, skills development*	Specialized
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://eclass.uop.gr/courses/3473/

(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 aim of the course is the in-depth understanding of the design of systems consisting of networked microcontrollers for the development of integrated monitoring and control applications, both locally and via the Internet (IoT). The course covers the architecture of advanced 32-bit microcontrollers (ESP32-C3, STM32) following the RISC architecture, the ways of connecting with analog/digital inputs/outputs using appropriate integrated circuits and common protocols (RS232, I2C, SPI, CAN) as well as and their interconnection through the MQTT protocol with IoT platforms (HiveMQ MQTT broker, ThingSpeak, ThingsBoard etc.) for the development of monitoring and control applications over the Internet. Emphasis is placed on the development of applications with C/C++ and MicroPython for dynamic load management and demand response in the context of dynamic pricing of the smart grid.

At the end of this course the students should:

<u>At the knowledge level:</u>

1. Know the functionality of modern microcontrollers in the Internet of Things (IoT) ecosystem.

2. Know the programming of ESP32-C3 microcontroller family.
3. Know the ways of connecting microcontrollers with analog/digital inputs/outputs.
4. Know the functionality of RS232, I2C, SPI and CAN protocols for connecting devices locally.
5. Know the interface of ESP32-C3 with IoT platforms, such as ThingSpeak and ThingsBoard, through the MQTT protocol.
6. Know ESP32-C3 programming with C/C++ and MicroPython.

At the level of skills - abilities:

1. Will be able to design microcomputer systems connected to memory and peripheral input/output devices in order to create complex monitoring and control applications both locally and over the Internet.
2. Will be able to design and implement programs on the ESP32-C3 microcontroller, in C/C++ and MicroPython for energy applications of the smart grid, such as dynamic load management and demand response response).

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, with the use of the necessary technology.
- Working independently.
- Teamwork (at the laboratory).
- Working in an international environment.
- Respect to the natural environment
- Production of free, creative and inductive thinking.

(3) SYLLABUS

Lectures:

The course consists of the following sections:

1. Introduction to Microcontrollers and their peripherals
   - General information about microcontrollers and the Internet of Things (IoT)
   - Principles of operation and architecture of RISC microcontrollers
   - Microcontroller families (RISC-V, ARM, AVR)
   - Microcontroller interfaces (GPIOs, ADC, DAC, UART, SPI, I2C, PWM)
   - Microcontroller peripherals (sensors, actuators, complex devices)
   - Interfacing microcontrollers with peripheral devices (analog/digital inputs/outputs, serial buses)

2. Microcontroller programming
   - Symbolic languages
   - High-level languages

3. Local monitoring and control applications

- Digital inputs/outputs
- Analog inputs/outputs
- Connecting devices with serial buses (UART, SPI, I2C, CAN)
- Control structures if, while, for
- Implementations on the ESP32-C3 microcontroller with C/C++ and MicroPython

4. Communication protocols and IoT
- Ethernet
- Wi-Fi (IEEE 802.11)
- IP
- TCP
- MQTT

5. Smart consumption meters (smart meters) and their communication methods.

6. Monitoring and control applications via MQTT broker for dynamic power management.

7. Cloud applications using databases, supervision and monitoring through web pages, creation of historical charts.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	• Face-to-face in the class and in the laboratory. • Distance learning through the e-Class platform.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• PowerPoint presentations of the course lectures, which have been uploaded to the e-Class page of the course. • Laboratory guide, at the e-Class page of the course. • Support of educational procedure through the e-Class platform for discussion and solving of relevant problems. • Espressif IoT Development Framework (IDF), Arduiono IDE, Wokwi. • Video and online examples.
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*	
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,*	(a) Final written exam of the theoretical part of the course. (b) Laboratory grade which consists of: - laboratory report grade (40%) - final laboratory exam (60%) The laboratory exercises are mandatory. The final grade of the course is derived as follows: Grade = (a)*60% +(b)*40% Evaluation language: Greek

Activity	***Semester workload***
Lectures	
Laboratory exercises	
Preparation for the laboratory exercises	
Personal study	
Course Total	

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.*	

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Μικροεπεξεργαστές, 2η έκδοση, Παπάζογλου Παναγιώτης
2. Κ. Πεκμεστζή, "Συστήματα μικροϋπολογιστών Ι: Μικροεπεξεργαστές 80x86, Pentium και ARM", Εκδόσεις Συμμετρία, 2009.
3. Δ. Πογαρίδη, "Σχεδίαση συστημάτων μικροεπεξεργαστών", Εκδόσεις Β. Γκιούρδα, 2006.
4. HiveMQ, "MQTT & MQTT 5 Essentials" URL: https://www.hivemq.com/mqtt-5/