COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**ECE_TEL960**	**SEMESTER**	**9**
COURSE TITLE	**INDUSTRIAL NETWORKS**		

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	
Seminars / Practice exercises	-	
Laboratory	2	
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 course: COMPUTER 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 course specializes in the engineering topic of Fieldbuses or Control networks as it has evolved lately. It aims to deliver the basic principles, architecture and functioning of microcontroller networking systems, 4th generation programmable logic controllers, fieldbus networks, industrial & building fieldbuses, industrial communication technologies in Industry 4.0 and Industrial Internet of Things. Then it analyzes ISO/OSI/ISA95 industrial network layer model, Medium access control (MAC) techniques, Application layer services & standards and User layer characteristics on an indicative fieldbus technology. The analysis includes various technologies and platforms of wired and wireless fieldbuses such as Lonworks, Industrial Ethernet, Profibus, CAN, ZigBee/Z-wave, WirelessHART as well as middleware and interoperability issues.

At the end of the course the student would also develop several additional skills such as:

- A deep theoretical and practical ability to cope with industrial communication & networking systems. He 'll be able to conceive their philosophy and use in the industrial, buildings and utilities fields of use. To understand their architecture and operation and to learn how they merge and co-operate with other technologies within the Industry 4.0 and the Industrial IoT domain.
- A good knowledge basis in applying and handling these current generation technologies in the field with emphasis in their basic programming, configuration and management techniques.
- An early experience in the design and development of complex distributed industrial / building / home "automation & control" systems and utilities systems for energy /resources management.

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 for, analysis and synthesis of data and information, with the use of the necessary theoretical concepts, terms and technology
- Adapting to new situations
- Decision-making
- Working independently
- Team work
- Critical thinking development
- Inductive thinking development
- Ability to make an idea work thru implementation
- Develop skills for applied research

(3) SYLLABUS

Theoretical course consists of the following chapters:

- The history of programmable automatic control in industrial evolution. Layered models of industrial production. Introduction of communication & networking in the industrial field. Industrial fieldbuses and evolution to Industry 4.0.
- Fieldbuses in Distributed automation & control systems. Networked microcontrollers. Structure, topology and architecture of fieldbuses.
- Real- time medium access control (MAC) technologies in fieldbuses.
- OSI/ISO/ISA95 5-layer model in fieldbus communication.
- Application Layer (7^{th}) and User Layer (8^{th}) analysis on an indicative fieldbus technology.
- Functional blocks, local & network variables, industrial device modeling, virtual & real manufacturing device models employing object-oriented design.
- Fieldbus management, integration and interoperability with data networks and the internet.
- IP device, IP appliance, IP everywhere, M2M.
- Industrial communication in the Industry 4.0 era and the Virtual Plant. Technologies and applications/services.
- The industrial Internet-of-Things iIoT. Technologies and applications/services.
- Building – Industrial – Utilities – Transportation automation. Energy and resources management.Technologies, applications & services.

The laboratory course consists of specific practical exercises on a Lonworks filedbus platform. It employs Visual Control – Graphical Software Tools for LonWorks DGS with Visual Control Graphical

Programming (VCGP) to create and design distributed controller applications with analog & digital I/O's and Visual Control Network Manager (VCNM) to configure and manage Lonworks fieldbus communication. It employs also LonMaker/LonPoint, a specific Lonworks graphical programming tool / platform to design, develop and implement distributed process control applications employing standard Lonmark objects (sensors, actuators, funcion blocks). The exercises are the following:

- Exercise 1. Basic principles in developing distributed control applications with Visual Control tools.
- Exercise 2. Design and develop a simple distributed control application in VCGP
- Exercise 3. Design and develop a complex distributed control application with digital I/O in VCGP
- Exercise 4. Design and develop a complex distributed control application with digital & analog I/O in VCGP
- Exercise 5. Design and develop a complex distributed control application with digital I/O in Neuron C (ANSI C based).
- Exercise 6. Design and develop a complex distributed control application with digital & analog I/O in LonMaker / LonPoint by Echelon.
- Exercise 7. Introduction to Lonworks – Mini EVK development toolkit. Initialize, download code, Debug.
- Exercise 8. Introduction to Lonworks Nodebuilder platform. Applications in Mini Gizmo Application Board with Thermistor, Buzzer, Switches, Leds

Additionally laboratory projects can be developed in the following platforms:

a. Pilot IoT running application with graphical representation of real-time variables via Google Gauges, Thingspeak (IoT service employing HTTP), IFTTT platform, processing, cloud or local data base. Dynamically updated diagrams and weekly/monthly statistics.
b. STM32F4G (ARM University Program Lab-in-a-Box) Discovery kit (32-bit ARM Cortex-M4 with FPU core), with STM32F4 Discovery Shield and On-board / Off-board (mikroBUS) modules - MikroElektronika (mikroBUS).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	▪ Power Point presentations. ▪ Laboratory exercises textbook. Available in typed and electronic form. (http://www.microlab.uop.gr & https://eclass.pat.teiwest.gr/) ▪ Laboratory exercises programs. ▪ Freeware downloadable tools. ▪ Further digital learning & educational/training material such as : associated videos, older exam solutions & problems solved for theory and lab, announcements, student registration & mail service, alerts, statistics, other educational services, etc. (http://www.microlab.uop.gr & https://eclass.pat.teiwest.gr/)

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*	

Activity	***Semester workload***
Lectures	2 x 13=26
Laboratory practice	2 x 13=26
Homework	67
Final exam (theory)	3
Final exam (lab)	3
Lectures	3 x 13=39
Course Total	***125 hours (5 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, 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.*	Language: Greek Evaluation: (a) Final written examination in theory. It includes all educational material described in (3) (b) Written and/or practical examination in every laboratory exercise. A weekly student assessment method for every laboratory exercise in being applied by means of an obligatory homework evaluation scheme for each student. All students prepare reports for every exercise, based in their development approach and deliver it for evaluation at the end of the semester. Final grade=0,6x(a) + 0,4x(b) The whole evaluation procedure and criteria are known to all students.

(5) ATTACHED BIBLIOGRAPHY

1. Industrial Computer Nettworks. S. Koubias, Professor, University of Patras Editions.
2. Echelon, Introduction to the Lonworks system, www.echelon.com / Support / documentation / presentations / default.htm, Echelon Corporation, 1999
3. Industrial communication technology handbook, Richard Zurawski ISA Group, San Francisco, California, CRC Press, 2015 by Taylor & Francis Group.
4. Industrial communication systems - The Industrial Electronics Handbook 2nd edition, Edited by Bogdan M. Wilamowski J. david Irwin, 2011 by Taylor and Francis Group,
5. N. P. Mahalik, Fieldbus technology: Industrial network standards for real-time distributed control, Springer, 2003
6. Open Control Networks, LonWorks/EIA 709 Technology, Editors: Loy, Dietmar, Dietrich, Dietmar, Schweinzer, Hans-Jörg, 2001.
7. Industrial Process Automation Systems, Design and Implementation, B.R. Mehta and Y.J. Reddy, 2015 Elsevier