COURSE OUTLINE

(1) GENERAL

SCHOOL	OF SCIENCE		
ACADEMIC UNIT	PHYSICS DEPARTMENT		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**M414**	**SEMESTER**	**1**
COURSE TITLE	Microelectronics-Design with VHDL-Laboratories		

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**
	6	9
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background-skills development
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/enrol/index.php?id=1406 and https://alpha.physics.uoi.gr/VHDL

(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*

In this course, the student acquires the necessary knowledge for the VLSI design of integrated circuits mainly in CMOS technology.
With the completion of the course the student:

- **understand the effects of the basic electronic elements of the electronic circuits in the performance of the integrated circuits**
- **is able to use standard and custom libraries in simple and composite logic gate design as well as to design custom logic circuits.**
- **is able to design dynamic logic in integrated circuits**
- **is able to design simple and complicated digital systems in integrated circuits as well as input-output structures taking in to account his/her knowledge on the effects of the related electronic parameters of them.**
- **is mindfully aware of the effects of the design methods in the performance**

of the integrated circuits

- **is mindfully aware of the influence of the parasitic element characteristics in the performance of the integrated circuits.**
- **Knows design techniques to reduce the power dissipation in the integrated circuits and applies them during the design.**

In addition in this course, the student acquires the necessary basic knowledge in the PLD technologies and in their programming using the VHDL. In particular with the completion of the course the student is in position:

- **to use the ISE design suite of Xilinx running in the Linux operating system.**
- **to design digital systems using VHDL, to debug and simulate them.**
- **to implement digital systems in FPGAs and PLDs and evaluate them.**

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…*
	…….

Working independently, Decision-making, production of free, creative and inductive thinking, Search for, analysis and synthesis of data and information with the use of the necessary technology.

(3) SYLLABUS

- Introduction to CMOS circuits (VLSI, MOS, CMOS, BiCMOS). CMOS logic (inverter, NOR, NAND, Compound gates), multiplexers, memory, registers. Circuit representations.
- MOS transistor theory, MOS device equations, CMOS inverter, SPICE simulation.
- Silicon Semiconductor processing technology, basic CMOS technology, interconnect, circuit elements (capacitors, resistors), layout design rules, Latchup.
- Circuit characterization and performance estimation, resistance-capacitance-inductance estimation
- Switching characteristics, delay models, transistor sizing
- Power dissipation, sizing routing conductors, charge sharing, design margining, process variations and yield
- CMOS circuit physical and logic design (inerter, NOR, NAND, NOR, XOR, complex logic gates layout)
- Transmission gate layout, Dynamic logic, clocking systems, input-output structures, overall organization of the physical design-Low power design.

- Laboratories: Design-simulation software, CMOS custom design examples (inverter, NAND, NOR, XOR, complex logic gates, dynamic logic and memories)

- VHDL design techniques for PLDs, simulation and implementation. In particular: Technologies of PLDs, circuit design, Synthesis, design levels of abstraction, simulation.

- XILINX ISE Design Suite.

- An Introduction to VHDL

  - entities, architecture, operators, simulation examples of logic gates and Boole functions.
  - concurrent VHDL, signals, delays, objects, classes, data types, concurrent statements, operators.
  - sequential VHDL , signals and variables, processes, components, statements,
  - libraries, subprograms, functions, procedures, packages, attributes,
  - Structural VHDL: component, port map, generic map, configuration. Examples.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to Face teaching and laboratory assistance
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	**All teaching material in ecourse tele-education system. The microwind package is used for microelectronics design labs in PCs. (windows operating system)** **For VHDL all teaching material in a web page. For VHDL labs the ISE XILINX design suite is used in PCs (Linux operating system) with XILINX Spartan 3-6 development systems (USB interface)**
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	60
Laboratories	40
Design practice at home	25
Laboratory examinations	5
Self-study and analysis	50
project	45
Course total	***225***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple*	For microelectronics

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.*	• Laboratory Student's performance (40%) • laboratory final exam in the integrated circuits design (60%) For VHDL: • Weekly home work (20%) • Project (30%) • Laboratory final exam (50%)

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:
- Related academic journals:

For microelectronics

N. Weste, K. Eshraghian: Principles of CMOS VLSI design (in English or translated in Greek)
R. Geiger, P. Allen, N. Strader: VLSI design for analog and digital circuits,
K. Laker, W Sansen: Design of analog integrated circuits and systems,

VLSI design software:

Etienne Sicard :MICROWIND2 : http://www.microwind.org/

For VHDL:

M. Mano, C. Kime, T. Martin, "Logic and Computer Design Fundamentals Paperback", (Pearson, 5th edition, 2015)
V. Pedroni, " **Circuit Design and Simulation with VHDL**", (MIT Press, 2010)