# COURSE OUTLINE

## GENERAL

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|---|---|---|---|
| SCHOOL | Engineering | | |
| ACADEMIC UNIT | Department of Computer Engineering & Informatics | | |
| LEVEL OF STUDIES | Undergraduate | | |
| COURSE CODE | CEID_NE4648 | SEMESTER | Spring (Selective Course) |
| COURSE TITLE | Introduction to VLSI Design | | |

| INDEPENDENT TEACHING ACTIVITIES<br>*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, Laboratory exercises | 3(L), 2(LE) | 5 |
| *Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).* | Total | 5 |

| | |
|---|---|
| COURSE TYPE<br>*general background, special background, specialised general knowledge, skills development* | Specialized knowledge |
| PREREQUISITE COURSES: | Logic Design I, Logic Design II, Computer Architecture I, Basic Electronics, Digital Electronics |
| LANGUAGE OF INSTRUCTION and EXAMINATIONS: | Greek |
| IS THE COURSE OFFERED TO ERASMUS STUDENTS | No |
| COURSE WEBSITE (URL) | https://www.ceid.upatras.gr/webpages/courses/vlsi/<br><br>https://www.ceid.upatras.gr/webpages/faculty/alexiou/vlsi/ |

## 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*

Upon successful completion of the course, a student will be able to :

(1) Design a PCB

(2) Program his design inside an FPGA

**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*
*……*
*Others…*
*…….*

Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas

## SYLLABUS

Part A : Lectures

Introduction to CMOS Circuits - Description of the operation of MOS transistors. The CMOS logic. Implementation of gates and simple circuits with CMOS logic: NAND, NOR, gateways, multiplexers and memory. Alternative ways of circuit representation: Behavioral, Structural and Physical. Comparison of CMOS and nMOS technologies. Theoretical analysis and study of MOS transistors. The nMOS enhancement transistor. Threshold voltage and ways of adjusting it.
The body-effect phenomenon. Electrical V-I characteristics of MOS transistors and characteristic equations. Analysis of the time and electrical characteristics of the CMOS inverter, the effect of βn / βp on their configuration and noise margins. Alternative CMOS inverters. Analysis of DC characteristics of the propagation gates. Study the latch-up phenomenon. CMOS-VLSI Circuit Building Technologies - Overview of semiconductor technology. Wafer manufacturing process, Oxidation, Selective diffusion.
The p-well, n-well and twin tub procedures. Improvements and process developments. Design rules. Ways of schematic representation. Lambda-based p-well and SOI rules. Parameterization of the manufacturing process. Circuit characterization and performance estimation - Resistance and capacity calculation. MOS transistor capacities. Diffusion and routing capacities. Design rules for RC effects control.
Time characteristics and design methods for determining: fall time, rise time and delay time. The role of geometric characteristics in determining transistor sizing and transistor (transistor sizing / scaling). Static and dynamic power consumption. The charge-sharing phenomenon. Calculation of yield. CMOS Logic Circuit Design Techniques.
Complementary CMOS, Pseudo-nMOS, Dynamic CMOS, CMOS C2OS, CMOS Domino, CVSL, Modified Domino, Pass Transistor. Design of logic gates (electrical and physical design). Clocking strategies: Pseudo 2-phase, 2-phase, 4-phase, Pseudo-4-phase and recommended approach modes.

**Part B. Laboratoty exercises**

The purpose of the lab is to design VLSI logic gates and small circuits. Laboratory exercises are done with the help of specialized design and simulation tools (Cadence)

1. Introduction using an example CMOS inverter (schematic, symbol)
2. Design and simulation of logical gateways: (FCMOS, Domino)
3. Design and simulation of a gate based circuit.
4. Design and simulation of memory circuits.
5. Calculation of VLSI Circuit Function Functions using design and simulation tools.

The lab takes place in the specially designed area of the Microelectronics Laboratory using high resolution terminals and servers that perform specialized commercial software. Contemporary implementation libraries are available to implement the design.

Licenses for software and libraries are provided by the Pan-European Support Agency of the Europractice Universities.

Conditions: Description of problem and method, Application environment, Communication, Parallel implementation and observations, Analysis of measurements. The laboratory is completed by writing a special report.

## TEACHING and LEARNING METHODS - EVALUATION

| | |
|---|---|
| DELIVERY | Face-to-face |

| | |
|---|---|
| *Face-to-face, Distance learning, etc.* | |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY**<br>*Use of ICT in teaching, laboratory education, communication with students* | Wide use of ICT and more specifically :<br>▪ The course is backed up by a web page providing all course material. This page is duly updated.<br>▪ The laboratory exercises and the semester project are announced electronically through this page, submitted also through this page and marking for them is also announced electronically.<br>▪ The preferred communication method with the students is via email. |
| **TEACHING METHODS**<br>*The manner and methods of teaching are described in detail.*<br>*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.*<br>*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**<br>Lectures — 26 hours<br>Recitation sections — 13 hours<br>Laboratory Exercises — 20 hours<br>Semester Project — 75 hours<br>Reports/Exams — 10+2 hour<br>***Course total*** — ***146 hours*** |
| **STUDENT PERFORMANCE EVALUATION**<br>*Description of the evaluation procedure*<br><br>*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*<br><br>*Specifically-defined evaluation criteria are given, and if and where they are accessible to students.* | The evaluation is performed in Greek language and is based on the reports submitted by the students for the lab exercises as well as on a presentation in parallel with an oral examination on their projects.<br><br>The evaluation is based on criteria already announced to the students, such as the degree of functionality their design offers, the implementation area that it requires as well as the maximum operation frequency that it can achieve. |

## ATTACHED BIBLIOGRAPHY

*- Suggested bibliography:*


- *CMOS VLSI Design: A Circuits and Systems Perspective Neil Weste, David Harris , 4th Edition, 2010*
- *CAD Tools Manuals*


*- Related academic journals:*

- IEEE Transactions on Computers
- IEEE Transactions on Circuits and Systems
- IEEE Transactions on VLSI Systems
- IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems