COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	"Politehnica" University of Bucharest
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Electronic Devices, Circuits and Architectures
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technologies
1.5 Cycle of studies	Undergraduate
1.6 Program of studies/Qualification	Telecommunication Systems and Technologies

2. Course identification information

2.1 Name of the course				Digital Integrated Circuits			
2.2 Lecturer				Lect. Zoltan Hascsi, Ph.D.			
2.3 Instructor for practical activities				Lect. Zoltan Hascsi, Ph.D.			
2.4 Year of studies	II	2.5 Semester	II	2.6 Evaluation type	Final examination	2.7 Course choice type	Mandatory

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week, out of which	4	3.2 course	3	3.3 practical activities	1
3.4 Total hours in the curricula, out of which	56	3.5 course	42	3.6 practical activities	14

3.7 Distribution of time	hours
Study according to the manual, course support, bibliography and hand notes	14
Supplemental documentation (library, electronic access resources, in the field, etc)	14
Preparation for practical activities, homeworks, essays, portfolios, etc.	20
Tutoring	0
Examinations	0
Other activities	0

3.8 Total hours of individual study	48
3.9 Total hours per semester	104
3.10 Number of ECTS credit points	4

4. Prerequisites (if applicable)

4.1 curricular	Computers Programming. Algebra. Electronic Devices
4.2 competence-based	General principles of structured programming. Functional description of electronic devices.

5. Requisites (if applicable)

5.1 for running the course	None
5.2 for running of the applications	None

6. Specific competences

6.1 Professional competences	C1. Using of fundamental elements that refer to the electronic devices, circuits and instrumentation C2. Application, in typical situations, of basic methods of signal acquisition and processing C3. Application of knowledge, concepts and basic methods that refer to the computer systems, microcontrollers, programming languages and techniques
6.2 Transversal competences	It is not the case

7. Course objectives (as implied by the grid of specific competences)

7.1 General objective of the course	The course answers the following questions: • What is a digital system? • How to describe a digital system? • How to simulate a digital system? • How to synthesize a digital system? • How to design a moderately complex digital system? Tackling the complexity and the functional diversity will enable students to design the simplest programmable system. Thus they are prepared to address the systems for which the functionality is achieved by physical and informational structuring.
7.2 Specific objectives	Students will learn to use ModelSim and Xilinx ISE to design and verify their digital circuits, and FPGA boards to implement and test them.

8. Content

8.1 Lectures	Teaching techniques	Remarks
8.1.1 Introduction: Analog vs. digital. Digital systems. Functional modules. Register.	Oral presentation with visual support (slide show)	1 hr
8.1.2 Digital system example (pixel corector): Functional description. Behavioral Verilog description. Simulation.		1 hr
8.1.3 Basic combinational logic circuits: Elemntary gates. Simple applications (zero detector, selector - multiplexer, adder).		1 hr
8.1.4 Basic sequential logic circuits: Elementary latches. Clocked latches. Master-slave principle. Registers. Counters.		3 hrs
8.1.5 CMOS circuits: Real digital signals. MOS switches. CMOS inverter. NAND and NOR gates. Multiple input gates. Tristate circuits. Transmission gateh. CMOS latch. Delay flip-flop.		4 hrs
8.1.6 Digital system structuring: Size and complexity. Subsystems interconnection. Structural growth by composition. Pipeline. Autonomy in digital systems. Digital systems classification.		3 hrs
8.1.7 Course target: the simplest programmable system: Functional description.		2 hrs

8.1.8 0'th order systems: combinational logic circuits Simple recursively defined circuits: decoder, demultiplexer, multiplexer, incrementer, adder, comparator. Complex circuits: ALU, multiplier, ROM		7 hrs
8.1.9 1'st order systems: memory circuits Combinational loop stability. Serial composition: master-slave circuits Parallel composition: random access memory Word-bits expansion. Word space expansion. Serial-parallel composition: register. Applications: Synchronous memory, register set, FPGA.		5 hrs
8.1.10 2'nd order systems: automata Elementary automata. T flip-flop. JK flip-flop. Counters. Finite state machine. FSM description and design.		7 hrs
8.1.11 3'rd order systems: processors FSM with "intelligent registers". Memory closed loops. The elementary processor.		5 hrs
8.1.12 4'th order systems Programmable systems. Asynchronous circuits. Metastability.		3 hrs
Bibliography: 1. Gheorghe M. Ştefan. *Loops & Complexity in Digital Systems. Lecture Notes on Digital Design in the Giga-Gate per Chip Era*. 2. Morris Mano. Michael Ciletti. *Digital Design*, 4th Ed. Pearson-Prentice Hall, 2007.		

8.3 Seminars	Teaching techniques	Remarks
8.3.1 Introduction to Verilog (variables, blocks, testbenches, modules).	Oral explanations and computer presentation of programs and simulations	2 hrs
8.3.2 Introduction to Xilinx ISE (project, synthesis).		2 hrs
8.3.3 Sequential blocks in Verilog (blocking versus non-blocking assignments, edge-triggered blocks, synchronous and asynchronous reset).		2 hrs
8.3.4 Verilog data vectors, RAM description in Verilog.		2 hrs
8.3.5 Counters, dividers, and signal generators in Verilog.		2 hrs
8.3.6 FSM description.		2 hrs
8.3.7 Propagation delays in Verilog.		2 hrs
Bibliography: http://wiki.dcae.pub.ro/index.php/Digital_Integrated_Circuits		

9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program

The course introduces the most important theoretical and practical elements that are necessary for digital design of low and medium complexity digital systems using Verilog HDL, offering specific abilities that will help students to obtain jobs in companies specialized in digital design.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final mark
10.4 Lectures	1. Knowledge of fundamental theoretical concepts; 2. Ability to describe a digital circuit in Verilog; 3. Ability to use simulation and synthesis tools;	10 quick tests 2 homework projects	10% 20%
		Final examination: • grid test • simulation, synthesis and implementation test	40%
10.5 Practical applications	Specific exercises and seminary work	grid test at every class	30%
10.6 Minimal performance standard			
Definition, description, simulation and synthesis of a finite state automaton from an informal description.			

Date — Lecturer — Instructor for practical activities,

25.09.2017 — Lect. Zoltan Hascsi, Ph.D. — Lect. Zoltan Hascsi, Ph.D.

Date of department approval — Head of Department,

26.09.2017

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Prof. Claudius Dan, Ph.D.