COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Applied Electronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Circuite integrate digitale Digital Integrated Circuits			
2.2 Course Lecturer				S.l./Lect. Dr. Zoltan Hascsi			
2.3 Instructor for practical activities				S.l./Lect. Dr. Zoltan Hascsi			
2.4 Year of studies	2	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type	D		2.9 Course code	04.D.04.O.017		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	4.5	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	2.5
3.4 Total hours in the curricula	63.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	35
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					60
Tutoring					1
Examinations					1
Other activities (if any):					0

3.7 Total hours of individual study	62.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Computer Programming Algebra Electronic Devices

4.2 Results of learning	General principles of structured programming Functional description of electronic devices

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	Room equipped with a video projector
5.2 Seminary/ Laboratory/Project	Room with computers/wotkstations Xilinx Vivado IDE FPGA development board Compulsory presence at laboratory classes, according to current NUSTPB regulations.

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

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.
Students will learn to use IDE tools to design and verify their digital circuits, and FPGA boards to implement and test them.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	**Design**, verification, implementation and testing of small- and medium-complexity digital circuits. Use of specific software and hardware tools. **Analysis** of schematics/descriptions of digital circuits. Understanding/inferring their behavior.
Transversal (General) Competences	Honorable, responsible and ethical behavior to ensure the reputation of the profession. Awareness of the need for continuous training. Efficient use of resources and learning techniques for personal and professional development. Understanding English terms. Ability to use documentation sources (standards, specifications, catalog data) in English.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The* *learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* **Define** the basic concepts of binary arithmetic and Boolean algebra. **Describe** logical functions using algebraic/tabular/graphical representations. **Describe** methods for automata description with graphs/flowcharts/state diagrams. **Exemplify** and characterize digital circuit implementation technologies. **Describe** the basic structures of digital circuits and explain their operation. **Define** metrics for digital circuit characterization and describe measurement/estimation methods for them. **Exemplify** digital circuit analysis/design methodologies. Enumerate and describe their stages. **Understand** the terms, abbreviations, acronyms and symbols used in the field of digital circuits.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* **Draw** the diagram of a digital circuit, at the level of transistors/logic gates/function blocks. **Behaviorally/structurally** describe a logic circuit using verilog language. **Interpret** the waveforms of a digital circuit simulation. **Identify** functional blocks in a digital circuit and infer its behavior to different input stimuli. **Analyze** a digital circuit diagram and deduce the logic function in the form of logic expression/diagram/graph. **Design** a combinational logic circuit using logic expressions/truth tables/VK diagrams. **Design** an automaton using state diagrams/graphs/flowcharts. **Design** a digital circuit combining generic functional blocks (mux, dmux, encoder, decoder, adder, comparator, register, counter, etc.). **Defiine** scenarios for generating input stimuli for a digital circuit and predict its response. **Find** and correct errors in the design and/or description of a non-functional circuit.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* **E**fficiently use the software tools and hardware resources for learning, analysis and design. **Select** appropriate documentation sources. **Reuse** and adapt old modules/circuits for new problems. **Demonstrate** autonomy in planning and implementing solutions to given problems, as well as identifying and correcting errors/mistakes. **Collaborate** with other colleagues and teaching staff in carrying out teaching activities. **Responsibly** apply the principles, norms and values of professional ethics in completing homework and laboratory assignments. **Self-evaluate** objectively, identifying gaps and needs, provide proactive feedback.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Teaching is based on the use of the videoprojector (covering communication and demonstration function). The oral communication methods are expository method and problem-solving method. Course materials are lecture notes and presentations. The lecture slides and course activities are available online on the faculty's "Moodle" platform.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction. Analog vs. digital. Combinational vs. sequential. Basic blocks: gates, flip-flops, registers.	2
2	Boolean algebra axioms. Elementary logic gates. CMOS implementation.	2
3	Boolean algebra theorems. Combinational logic circuits.	4
4	General-purpose CLCs: multiplexers and demultiplexers.	2
5	Complex CLCs.	2
6	Bistables. Flip-flops. Registers.	2
7	Counters	2
8	Memories. ROM. RAM.	2
9	Automata	4
10	Arithmetic circuits. Adders. Shifters. Multipliers.	2
11	Digital systems. Structured design. Size and complexity.	4
	Total:	28

Bibliography:

- http://curs.upb.ro/
- Morris Mano. Michael Ciletti. Digital Design, 4th Ed. Pearson-Prentice Hall, 2007

LABORATORY		
Crt. no.	**Content**	**No. hours**
1	Introduction to Vivado (project, simulation, synthesis)	2
2	Introduction to Verilog (module, instance etc)	2
3	CLC. Multiplexers. Adders.	2
4	Decoders. LCD Display. BCD Converter.	2
5	CLC project (decimal adder)	2
6	CLC colloquium	2
7	Flip-flops. Shift register	2
8	Counters	2
9	ROM and RAM memories	2
10	Mealy and Moore FSMs	2
11	CLS project (triangular sequence generator)	2
12	CLS colloquium	2
13	Complex project (pocket calculator)	4
	Total:	28
SEMINARY		
Crt. no.	**Content**	**No. hours**

1	Binary arithmetic	1
2	Normal disjunctive/conjunctive forms	1
3	Logic functions with MUX and DMUX	1
4	V-K diagrams	1
5	Minimizations with V-K diagrams	1
6	Automata with D flip-flops	1
7	Automata with counters	1
	Total:	7

Bibliography:

- https://wiki.dcae.pub.ro/index.php/Digital_Integrated_Circuits_(lab)

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	knowledge of fundamental theoretical concepts	Quick tests	10%
	knowledge of fundamental theoretical notions; design and verification of a digital circuit in verilog; the ability to use simulation and synthesis tools;	Final exam	50%
11.5 Seminary/laboratory/project	verilog description and simulation of combinational digital circuits	colloquium	15%
	verilog description and simulation of sequential digital circuits	colloquium	25%
11.6 Passing conditions			
At least 50% of the total marks. At least 50% of the marks alloted to laboratory colloquims			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

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.

Date	Course lecturer	Instructor(s) for practical activities
	S.l./Lect. Dr. Zoltan Hascsi	S.l./Lect. Dr. Zoltan Hascsi

Date of department approval	Head of department
Date of approval in the Faculty Council	Dean