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	Masters
1.6 Programme of studies	Microsystems

2. Date despre disciplină

2.1 Course name (ro) (en)				Electronica funcțională			
2.2 Course Lecturer				Prof. Dr. Ing. Gheorghe M. Ștefan			
2.3 Instructor for practical activities				Prof. Dr. Ing. Gheorghe M. Ștefan			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DS	2.9 Course code	UPB.04.M2.O.03-08		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	14
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.					48
Tutoring					7
Examinations					3
Other activities (if any):					0

3.7 Total hours of individual study	58.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Computer Programming, Discrete Mathematics, Digital Integrate Circuits, Computer Architecture

4.2 Results of learning	Verilog programming language, assembly languages, theory of automata, theory of computation

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

5.1 Course	Room equipped with video projector
5.2 Seminary/ Laboratory/Project	Laboratory equipped with computers and the Vivado software.

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)*

This course answer the following questions:

- What is a hybrid computational system and how it is used in functional electronics?
- How is a hybrid computational system described?
- How is simulated a hybrid computational system?
- How is made the synthesis a hybrid computational system?
- How is designed a medium complexity hybrid computational system?

Functional diversity and complexity approached will allow the student to design the simplest hybrid computational system. The student is therefore prepared to approach systems in which the functionality is obtained through physical and informational structuring.

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	Description of the ***hybrid computing systems*** used in designing ***parallel embedded applications***. What is their functionality and how they work. Principles and methods for designing and testing hybrid systems based on ***accelerators*** implemented in FPGA technology. Analysis of the hybrid computing systems of low/medium complexity, aiming their design and simulation. Design and simulation of the hybrid computing systems using the Vivado environment.
Transversal (General) Competences	Logical and critical thinking, Ability to analyze and break down a problem into consecutive steps

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.* General concepts regarding various algorithms and applications. Using the Verilog HDL language and a custom simulation environment.
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).* Proiectarea și optimizarea circuitelor digitale pentru FPGA și dezvoltarea de aplicații pentru a le integra în sisteme complexe
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Applying the concepts learned in this course, students will be able to evaluate the performance criteria of digital computing circuits targeting FPGA devices.

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.)*

Problematization and case study will be used to raise students' interest in the general objectives of the course. To check the understanding of new concepts, the conversation method will be used to assess the students' understanding. Exposition and explanation will be used in the process of teaching new concepts.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	1 Introduction: what functional electronics is? • Fuction vs. structure • Size v.s complexity • Embedded systems	2
2	Parallel computation • Stephen Kleene’s model of partial recursive functions • Kleene Machine and Universal Kleene Machine • Parallel programming • Kleene-Bachus synergy	4
3	Abstract model for a parallel computing engine • MapReduce hyerarchy of parellel engines • mapReduce circuit	2
4	Linear algebra on the family of mapReduce circuits • Dense structures • Rare structures • Limited IO computation	6

5	Convolutional neural networks, CNN • Neural networks • Deep neural networks • Accelerating the training and functioning of convolutional neural networks	6
6	Machine Learning • Clustering • Descending Dimension Algorithms • Regresion • Suport Vector Machine	8
	Total:	28

Bibliography:

Gheorghe M. Ștefan: Loops & Complexity in Digital Systems. Lecture Notes on Digital Design in the Giga-Gate per Chip Era

Gheorghe M. Ștefan: Functional Electronics – Lecture Notes on Parallel Embedded Systems,

PROJECT

Crt. no.	**Content**	**No. hours**
1	Simulation exercises on the hybrid system simulator with MapReduce accelerator	4
2	Implementation of dense linear algebra functions	2
3	Implementation of the functions required by the individual project centered on machine learning algorithms	8
	Total:	14

Bibliography:

Gheorghe M. Ștefan: Simulation Manual for the Configurable MapReduce Accelerator
Krste Asanović, at al.: The Landscape of Parallel Computing Research: A View from Berkeley

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	1. knowledge of fundamental theoretical notions. 2. the ability to describe a digital circuit in Verilog 3. the ability to use simulation and synthesis tools	Final presentation of the project	40
	1. knowledge of fundamental theoretical notions. 2. the ability to describe a digital circuit in Verilog 3. the ability to use simulation and synthesis tools	Homework	20
11.5 Seminary/laboratory/project	Exercises and applications specific to each laboratory work	Test at each lab/project	40
11.6 Passing conditions			

Minimum 50% of the total score.

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 discipline teaches the main theoretical and practical elements needed to design hybrid embedded systems of low and medium complexity using the Verilog HDL language and a simple assembly language. The acquired skills are practiced on machine learning applications. It offers certain skills that can be considered assets for the employment of students in companies specializing in the design of complex digital systems.

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Ing. Gheorghe M. Ștefan	Prof. Dr. Ing. Gheorghe M. Ștefan
Date of department approval	Head of department	
31.10.2024	Prof. Dr. Claudius DAN	
Date of approval in the Faculty Council	Dean	
01.11.2024	Prof. Dr. Mihnea Udrea	