SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electrical Engineering
1.3 Department	Electrotechnics and Measurements
1.4 Field of study	Electrical Engineering
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Electrical System Cluj-Napoca in English language
1.7 Form of education	Full time
1.8 Subject code	53.20

2. Subject description

2.1 Subject name					FPGA and DSP based system design	
2.2 Course responsible / lecturer					Assist. Prof. Eng. Ioana Cornelia GROS, PhD Asist. Eng. Pintilie Lucian – Nicolae, PhD	
2.3 Teachers in charge of laboratory activity					Asist. Eng. Pintilie Lucian – Nicolae, PhD	
2.4 Year of study	IV	2.5 Semester	II	2.6 Assessment	C	
2.7 Subject category	Formative category				DS	
	Optionality				DO	

3. Total estimated time

3.1 Number of hours per week	4	of which:	3.2 Course	2	3.3 Seminary	-	3.3 Laboratory	2	3.3 Project	-
3.4 Total hours in the semester	56	of which:	3.5 Course	28	3.6 Seminary	-	3.6 Laboratory	28	3.6 Project	-

3.7 Overall semestrial time distribution [hours]:	
(a) Manual book, lecture material and notes, bibliography	22
(b) Supplementary study in the library, online and in the field	6
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	10
(d) Tutoring	4
(e) Exams and tests	2
(f) Other activities	-

3.8 Total hours of individual study (summ (3.7(a)…3.7(f)))	44
3.9 Total hours per semester (3.4+3.8)	100
3.10 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	Computer architecture basics; Computer programming basics; Microprocessor system design basics; Logic or digital circuits (boolean math); Signal processing, Low power electronics; Power Electroincs; Circuit solving theory;
4.2 Competence	C standard / C++ / Wiring C and Python programming; Embedded systems circuit design skills;

5. Specific competences

5.1. For the course	On-line / On-site
5.2. For the applications Laboratory	On-line / On-site with mandatory presence

6. Specific competences

Professional competences	C2. Use of basic concepts of applied electronics, logic circuits, boolean math, signal processing and acquisition, computer science and computer networks; C4. Use of modern methods of simulation, design and testing for power electronics converters and electrical drives (ex. Hardware In the Loop - HIL, Processor In the Loop - PIL, FPGA In the Loop - FIL, Rapid Control Prototyping - RCP); C4.1. Use of numeric methods for simulation and solving power electronics circuits; C4.2. Use of modern simulation, testing and graphical programming software; C4.3. Use of power electronics and drives dedicated simulation and programming software; C4.4. Use of system identification and automated control theory; C4.5. Design of electrical drives using embedded systems and modern computer computer aiding technologies;
Cross competences	- to develop learning techniques through individual study; - to efficiently use the sources of information and communication; - to be able to integrate in a work team;

7. Discipline objectives (as results from the key competences gained)

7.1 General objective	Use of DSP and FPGA based systems for solving Electrical Engineering problems and to design power electronics circuits for electrical drives;
7.2 Specific objectives	Coherent study of FPGA and DSP computing systems, with the aim of acquiring detailed knowledge in: - dedicated computer acrchitectures for aiding ultra-fast processes; - industrial computer programming; - design, testing and implementation of the control law or strategy;

8. Contents

8.1 Lecture (syllabus)	Number of hours	Teaching methods	Notes
1. Field Programmable Gate Array circuits - short introduction	2	Speech and discussions (On – Line or On – site)	Using PowerPoint presentations
2. The architecture of FPGA circuits	2		
3. Configurable logic circuits	2		
4. Multiplexers and Look-Up Tables	2		
5. Fuse and antifuse circuits in FPGA	2		
6. Configurable logic blocks – Matrix of CLB	2		
7. Interconnection of configurable logic blocks – Switch Matrix	2		
8. The architecture of digital signal processors TMS320C4x	2		
9. Levels of parallelism (parallel tasks)	2		
10. Memory structure – Internal registers	2		
11. Methods of addressing – Data types	2		
12. Structure of DSP systems	2		
13. DSP based systems – TMS320C4x	2		
14. Cube structures, hypercube, ring, pyramid.	2		

Bibliography
[1] Teodor PANĂ, Controlul sistemelor de acționare vectorială cu motoare de inducție, Editura Mediamira, 2001;
[2] Teodor Pană „MATLAB în sistemele de acționare electrică automate”, curs, Litografia UTCN, 1996;
[3] Cărți:
[4] F. Blaschke, „The Method of Field Orientation for Control of Three Phase Machines”, Ph.D. dissertation, TU Braunschweig, 1974;
[5] S. Călin, C. Belea, „Sisteme automate adaptive și optimale”, Editura tehnica București, 1971;
[6] Y. Hori, V. Cotter and Y. Kaya, „A Novel Induction Motor Machine Flux Observer and its
[7] Application to a High Performance AC Drive System,";
[8] 6. Ioana Gros, L. Pintile, T.Pană, Sisteme embedded în inginerie electrică – ghid de aplicații https://biblioteca.utcluj.ro/files/carti-online-cu-coperta/431-5.pdf.

8.2 Laboratory	Number of hours	Teaching methods	Notes
1. Short introduction to the DSP based computing systems: A. Study of DSP based computing systems; B. Methods of programming DSP based computing systems;	4	Speech, discussions and experiments (On – Line or On – site)	Using PowerPoint presentations, experimental platforms and development boards
2. Solving Electrical Engineering problems using DSP systems: A. Short introduction to Altair – SolidThinking Embed (VisSim); B. Proof of the fundamental sampling theorem – the Nyquist – Shannon theorem);	4		
3. Design and implementation of the control law or strategy: A. Basic Brushless DC motor control; B. Volt / Frequency control of a three phase inverter + motor;	4		
4. Short introduction to the FPGA based computing systems: A. Study of FPGA based computing systems; B. Methods of programming FPGA based computing systems;	4		
5. Different methods of re-configuration: A. FPGA as a microcontroller – The MICROBLAZE technology; B. Partial re-configuration;	4		
6. Solving Electrical Engineering problems using FPGA systems: A. Implementation of logic circuits using Xilinx System Generator; B. Implementation of logic circuits using HDL Coder;	4		
7. Real-time testing and simulation methods using FPGA + DSP: A. Example of Rapid Control Prototyping testing methods; B. Example of Hardware In the Loop testing methods;	4		

Bibliography:
1. Teodor Crișan Pană – „Sisteme de calcul cu microprocesoare, FPGA și DSP” – Editura UTPRESS, Cluj – Napoca, 2016 – ISBN 978-606-737-206-9;
2. Ioana – Cornelia GROS, Lucian – Nicolae PINTILIE, Teodor Crișan PANĂ – „SISTEME EMBEDDED ÎN INGINERIE ELECTRICĂ - GHID DE APLICAȚII” – Editura UTPress Cluj – Napoca, 2020 ISBN 978-606-737-431-5: (https://biblioteca.utcluj.ro/files/carti-online-cu-coperta/431-5.pdf);

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The acquired competencies are necessary for positions in the domain of embedded systems, automation, design and programming of control circuits, and real-time testing.

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	The exam consists of checking knowledge by solving problems and a theory part (multiple choice questions)	Written exam – 1 hour	50 %
10.5 Laboratory	Solving a high degree of complexity homework	Weekly evaluation	50 %
10.6 Minimum standard of performance: N≥5; L≥5; MS≥5;			

Date of filling in: 01.08.2024	**Lecturers**	**Title Surname Name**	**Semnătura**
	Curs	Assist. Prof .Eng. GROS Ioana-Cornelia, Phd	
	Aplicații	Asist. Eng. PINTILIE Lucian – Nicolae, PhD	

Date of approval in the ETHM Department Council September 2024	**H**Head of Department: Prof. Eng. MICU Dan Doru, PhD
Date of approval in the Faculty of Electrical Engineering Council September 2024	**Dean:** Assoc. Prof. Eng. CZIKER Andrei, PhD