SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications, and Information Technology
1.3	Department	Bases of Electronics
1.4	Field of study	Electronics and Telecommunications Engineering
1.5	Cycle of study	Master of Science
1.6	Program of study/Qualification	Integrated Circuits and Systems
1.7	Form of education	Full time
1.8	Subject code	3.00

2. Data about the subject

2.1	Subject name					VLDI Digital Circuit Design					
2.2	Subject area					Theoretic area Methodological area Analytical area					
2.3	Course responsible/lecturer					Prof.Dr.Ing. Sorin Hintea – Sorin.Hintea@bel.utcluj.ro					
2.4	Teachers in charge of applications					Sl. Dr.Ing. Gabor Csipkes – Gabor.Csipkes@bel.utcluj.ro					
2.5	Year of study	I	2.6	Semester	1	2.7	Assessment	Exam	2.8	Subject category	DS/DI

3. Estimated total time

3.1 Hours per week	4	of which 3.2 lecture	2	3.3 tutorial / laboratory	2
3.4 Total hours in curricula	56	of which 3.5 lecture	28	3.6 tutorial / laboratory	28
Time allocation					hours
Manual, lecture material and notes, bibliography					28
Supplementary study in the library, online and in the field					12
Preparation for seminars/laboratory works, homework, reports, portfolios, essays					24
Tutoring					3
Exams and tests					2

3.7 Total hours of individual study	69
3.8 Total hours per semester	125

Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	• Electronic devices • Fundamental electronic circuits • Analysis and synthesis of numeric circuits • Systems with digital integrated circuits
4.2 Competence	• Fundamental electronic devices and circuits. Basic knowledge about how MOS transistors work, • Elements of logical algebra, • Internal structures of digital circuits, • Conceptions about digital signal processing and transmission, • HDL languages, • Basic knowledge of computer-aided design environments for digital circuits.

5. Requirements (where appropriate)

5.1 For lecture	Cluj-Napoca
5.2 For applications: Project	Cluj-Napoca

6. Specific competences

Professional competences	Structure and parameters of MOS transistors. CMOS inverter. Transmission gate. Three-state output. Manufacturing technology of CMOS circuits and design rules. Manufacturing technology of MOS transistors. Layout design rules. Physical design of CMOS circuits. CMOS layout design techniques. Examples of physical design of CMOS circuits Performance analysis of CMOS circuits. The parameters that influence the working speed of the circuits. Propagation of signals. Design techniques for controlling large capacitive loads. Determination of parasitic capacities and resistances. The design of combinational logic circuits. Complementary CMOS logic. Dynamic logic. C2MOS logic. CMOS domino logic. Realization of sequential VLSI circuits. Propagation errors in sequential systems. Elimination of propagation errors. Logic structures with a clock. Memory structures with a clock. Multi-phase structures Signal propagation problems in VLSI digital circuits. Synchronous and asynchronous circuits. Designing synchronous circuits. Circuits with own clock. Synchronization of asynchronous signals using PLL loops. Trends in modern design. Examples of circuits made with VLSI CMOS structures. Parity circuits, decoders, etc. Synchronous sequential circuits with synchronous and asynchronous counters. Synchronous sequential circuits with registers. Programmable circuits made in VLSI CMOS technology. ROM memories. RAM memories. Programmable logical areas. Arithmetic circuits made in VLSI technology. adders, subtractors, multipliers, shift registers. Improving the performance of high-capacity arithmetic circuits. Designing memories and logical areas. Memory architectures. Memory cell structures. Peripheral circuits in the memory structure. Case studies.

Transversal competences	

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

7.1 General objectives	Skill development in the field of VLSI digital circuits design
7.2 Specific objectives	1. Assimilation of theoretical knowledge regarding the design of VLSI digital circuits 2. Obtaining the skills for using specific analysis, simulation and design tools

8. Contents

8.1. Lecture (syllabus)	Teaching methods	Notes
Introduction to VLSI digital systems. History. Design stages. Basic concepts. VLSI design methods.	Presentation, discussion	Laptop, projector
Structure and parameters of MOS transistors. Enhancement channel NMOS transistors. Enhancement channel PMOS transistors. Depletion transistors. Calculation of circuit elements. Resistors. Capacitors. CMOS inverter. Diagram of the inverter. Description of the inverter operation. Influence of device geometry. The noise margin. Other types of inverters. MOS inverter with resistive load. NMOS inverter with enhancement NMOS load. The NMOS inverter with enhancement NMOS load. The pseudo-NMOS inverter. Transmission gate. Three-state output.		
Manufacturing technology of CMOS circuits and design rules. Manufacturing technology of MOS transistors. n-well CMOS process. Advanced CMOS circuit manufacturing technologies. Layout design rules.		
Physical design of CMOS circuits. CMOS layout design techniques. CMOS inverter. Physical design of logic gates. Complex CMOS gates. Examples of physical design of CMOS circuits		
Performance analysis of CMOS circuits. Switching characteristics. The parameters that influence the working speed of the circuits. Propagation of signals. Design techniques for controlling large capacitive loads. Determination of parasitic capacities and resistances.		
The design of combinational logic circuits. Complementary CMOS logic. Dynamic logic. C2MOS logic. CMOS domino logic		
Designing sequential logic circuits. Implementation of sequential VLSI circuits. Propagation errors in sequential systems. Elimination of propagation errors. Logic structures with a clock. Memory structures with a clock. Multi-phase structures		
Signal propagation problems in VLSI digital circuits. Synchronous and asynchronous circuits. Designing synchronous circuits. Circuits with own clock. Synchronization of asynchronous signals using PLL loops. Trends in modern design		
Examples of circuits made with VLSI CMOS structures. Parity circuits, decoders, etc. ALU units. Synchronous sequential circuits with synchronous and asynchronous counters. Synchronous sequential circuits with registers. Programmable circuits made in VLSI CMOS technology. ROM memories. RAM memories. Programmable logical areas. PLA and PAL applications.		
Arithmetic circuits made in VLSI technology. adders, subtractors, multipliers, shift registers. Improving the performance of high capacity arithmetic circuits.		
Designing memories and logical areas. Memory architectures. Memory cell structures. Peripheral circuits in the memory structure. Dissipated power. Case studies.		
Low power digital VLSI circuits and systems. The problem power consumption.		

Specific problems in the design of low power circuits. Techniques for reducing the power dissipated in digital circuits.			
Simulation of VLSI circuits. Using the Mentor Graphics design environment. Using the Xilinx Foundation and Ise Webpack environments.			
Testing of integrated digital systems. Design requirements for testing. Retention techniques. Errors in CMOS digital circuits. Testing of combinational and sequential circuits.			
8.2 Laboratory		Teaching methods	Notes
1	Introduction to the Mentor Graphics design and simulation environment	Didactic and experimental proof, didactic exercise, team work	Use of laboratory instrumentation, experimental boards, computers, white/magnetic board
2	Examples of simulating simple blocks with Eldo		
3	ICflow layout package and Caliber xRC extraction – examples for some elementary gates		
4	Simulation of signal propagation through combinational circuits		
5	Basic cells in fractional frequency dividers - programmable integer divider		
6	Basic cells in fractional frequency dividers - rate multipliers		
7	Basic cells in fractional frequency dividers - pulse extractors ("pulse swallower")		
8	Functional simulation of the fractional divisor. Layout elements		
9	Advanced arithmetic circuit structures – advanced 1-bit adders		
10	8-bit full adder - case study and hybrid realization with propagation and carry anticipation		
11	8-bit full adder – layout elements		
12	Signal propagation through digital circuits: the study of delays and logical hazard		
13	Optimizing the propagation delay through critical paths		
14	Circuits with large load capacitances		

Bibliography

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nicolic, *Digital Integrated Circits, second edition*, Prentice Hall, 2003
2. Neil H. E. Weste, David Harris, *CMOS VLSI Design: A Circuits and System Perspective, third edition*, Addison Wesley, 2004
3. John F. Wakerly, *Circuite digitale – Principiile şi practicile folosite în proiectare*, Teora, 2005
4. Barry Wilkinson, *Electronica Digitală*, Teora, 2005
5. Sorin Hintea, *Tehnici de proiectare a circuitelor digitale VLSI* , Editura Casa Cărţii de Ştiinţă, Cluj-Napoca, 1998
6. Geiger, Randall, Allen, Phillip E., Strader, Noel R. *VLSI design techniques for analog digital circuits*, McGraw – Hill Publishing Company, 1990
7. Milos Ercegovac, Tomas Lang, Jaime H. Moreno. *Introduction to Digital Systems.* John Wiley & Sons, Inc. 1999

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

The skills acquired will be necessary for employees in the following possible occupations according to COR:
electronics engineer, electronics engineer designer, applied electronics research engineer, engineer of microelectronics research, electrotechnology engineers, information technology manager and communications, systems and computer engineer designer, communications designer engineer, specialists in information technology.

10. Evaluations

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Lecture	Solving two theoretic questions and a set of multiple choice questions	- Written exam	33%
10.4 Laboratory	Solving an application with a written and report and presentation	- Written report	33%
10.5 Project	Verification of the skills and abilities acquired as a result of the project activities	- Semester-long verification through periodic presentation of the project	33%
10.6 Minimum standard of performance			
• Each of the three assessments			

Date of filling in:	Responsible	Title Surname NAME	Signature
	Course	Prof.Dr.Ing. Sorin HINTEA	
	Aplications	Sl. Dr.Ing. Gabor CSIPKES	

Date of approval in the Department of Bases of Electronics

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Head of Department

Prof. Sorin HINTEA, PhD eng

Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology

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Dean

Prof. Ovidiu POP, PhD eng