SYLLABUS

1. Program information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Bases of Electronics
1.4 Field of study	Electronic engineering, telecommunications and information technologies
1.5 Cycle of study	Bachelor of Science
1.6 Study program / Qualification	Electronic engineering, telecommunications and information technologies/ Engineer
1.7 Form of education	IF – full-time education

2. Course information

2.1 Course title	Digital integrated circuits				Course code	19.00
2.2 Course coordinator	*Assoc.prof. Mihaela CÎRLUGEA, Ph.D. – Mihaela.Cirlugea@bel.utcluj.ro*					
2.3 Seminar/ laboratory/ project/ practical activity coordinator	*Assoc.prof. Mihaela CÎRLUGEA, Ph.D. – Mihaela.Cirlugea@bel.utcluj.ro* *Assoc.prof. Paul FARAGÓ, Ph.D. – Paul.FARAGO@bel.utcluj.ro*					
2.4 Year of study	II	2.5 Semester	1	2.6 Type of assessment		E
2.7 Course status	Formative category					DD
	Optionality					DOB

3. Estimated total time

3.1 Hours per week	4	of which:	3.2 Lecture	2	3.3 Seminar	1	3.3 Laboratory	1	3.3 Project	0	3.3 Practical training	0
3.4 Hours per semester	56	of which:	3.5 Lecture	28	3.6 Seminar	14	3.6 Laboratory	14	3.6 Project	0	3.3 Practical training	0

3.7 Time distribution (hours per semester) for individual study and assessment:	
(a) Assessment	3
(b) Study using textbook, course materials, bibliography, and notes	14
(c) Additional documentation in the library, on specialized electronic platforms, and in the field	10
(d) Preparation for seminars/laboratories, assignments, reports, portfolios and essays	14
(e) Tutoring	3
(f) Other activities	-

3.8 Total hours of individual study and assessment (sum of (3.7(a)...3.7(f))	44
3.9 Total hours per semester (3.4+3.8)	100

3.10 Number of credits	4.0

4. Prerequisites (where applicable)

4.1 curriculum	Passive Components and Circuits; Electronic Devices
4.2 competencies	Number systems, elements of binary arithmetic, and elements of Boolean algebra; Analysis of electrical circuits using fundamental circuit laws and theorems; Basic use of measurement instruments and simulation environments; Basic use of computers and technical software applications.

5. Requirements (where applicable)

5.1. for the development of the lecture	Lecture room equipped with a computer, multimedia projector with a connectivity hub for external laptops, projection screen, whiteboard/blackboard, and Internet access.
5.2. for the development of the seminar/ laboratory/ project	Seminar room and laboratory equipped with computers, testing and prototyping boards, laboratory instruments, FPGA development boards, multimedia projector with a connectivity hub for external laptops, whiteboard/blackboard, and Internet access.

6. Specific competencies acquired

Professional competencies	C1 Use of fundamental elements related to electronic devices, circuits, systems, instrumentation and technology C1.1 Description of the operation of electronic devices and circuits and of the fundamental methods for measuring electrical quantities C1.5 Design and implementation of low-/medium-complexity electronic circuits using CAD-CAM technologies and standards in the field C2 Application of basic methods for signal acquisition and processing C2.1 Time-domain, spectral and statistical characterization of signals C2.2 Explanation and interpretation of signal acquisition and processing methods C2.3 Use of simulation environments for signal analysis and processing C2.4 Use of specific methods and instruments for signal analysis C2.5 Design of elementary functional blocks for digital signal processing with hardware and software implementation C3 Application of basic knowledge, concepts and methods related to computer-system architecture, microprocessors, microcontrollers, programming languages and techniques C3.1 Description of the operation of a computer system, of the basic principles of general-purpose microprocessor and microcontroller architecture, and of the general principles of structured programming C3.2 Use of general-purpose programming languages and languages specific to microprocessor and microcontroller applications; explanation of the operation of automatic control systems using these architectures and interpretation of experimental results C3.4 Development of programs in a general-purpose and/or specific programming language, from requirements specification to execution, debugging and interpretation of the results in relation to the processor used

Professional competencies	C4 Design and use of low-complexity hardware and software applications specific to applied electronics C4.1 Definition of the concepts, principles and methods used in: computer programming, high-level and specific languages, CAD techniques for creating electronic modules, microcontrollers, computer-system architecture, programmable electronic systems, graphics and reconfigurable hardware architectures C4.2 Explanation and interpretation of the requirements specific to hardware and software structures in the fields of: computer programming, high-level and specific languages, CAD techniques for creating electronic modules, microcontrollers, computer-system architecture, programmable electronic systems, graphics and reconfigurable hardware architectures C4.3 Identification and optimization of hardware and software solutions for problems related to industrial electronics, medical electronics, automotive electronics, automation, robotics and consumer-goods production C4.4 Use of appropriate performance criteria to evaluate, including by simulation, the hardware and software of dedicated systems or service activities using microcontrollers or low-/medium-complexity computer systems C5 Application of basic knowledge, concepts and methods from: power electronics, automatic systems, electrical energy management and electromagnetic compatibility C5.1 Definition of the specific elements that characterize electronic devices and circuits in the fields of: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods C5.2 Qualitative and quantitative interpretation of the operation of circuits in the fields of: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods; analysis of operation from the standpoint of electromagnetic compatibility C5.5 Design, using established principles and methods, of low-complexity subsystems in the fields of applied electronics: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods
Transversal competencie	

7. Expected learning outcomes

Knowledge	- The student/graduate explains and interprets theoretical and experimental results in mathematics, physics, chemistry, economics, technical drawing and computer science. - The student/graduate describes, identifies and summarizes elementary concepts and methods related to electronic devices, circuits and instrumentation, as well as their application in concrete problems.
Skills	- The student/graduate applies evaluation criteria and methods for identifying, modelling, experimenting, analysing and qualitatively and quantitatively assessing phenomena and processes specific to the fundamental field, including by using digital technologies. - The student/graduate designs solutions, in compliance with relevant standards, for medium-complexity engineering problems that meet specified needs, while observing requirements related to public health, safety, welfare, environment, sustainability and economic factors, as well as other specific constraints.

Skills	- The student/graduate uses fundamental methods for measuring electrical quantities and assesses electronic devices and circuits, as well as linear and digital integrated circuits of low/medium complexity. - The student/graduate designs, measures, evaluates performance, diagnoses and troubleshoots functional blocks composed of low/medium-complexity electronic devices and/or circuits.
Responsibility and autonomy	- The student/graduate carries out project management processes in electronics, telecommunications and information technologies, taking on different team roles and clearly and concisely describing the results, both orally and in writing.

8. Course objectives (based on the grid of specific competencies acquired)

8.1 General objective of the course	To provide the theoretical and practical foundations required for the analysis, design, modeling, implementation, and verification of low- and medium-complexity combinational and sequential digital circuits, as well as for their integration into functional digital systems.
8.2 Specific objectives	To develop an understanding of the binary representation of information and the principles of digital abstraction. To familiarize students with Boolean algebra, canonical forms, and methods for minimizing logic functions. To develop the ability to implement Boolean functions using logic gates, multiplexers, demultiplexers, decoders, and encoders. To develop the ability to analyze and design sequential circuits using latches, flip-flops, registers, and counters. To develop the ability to integrate combinational and sequential blocks into hierarchical and modular digital systems. To develop the ability to create testbenches and verify normal circuit operation.

9. Contents

9.1 Lecture	**No. of hours**	**Teaching methods**	**Remarks**
1. Introduction to digital integrated circuits: Binary representation; logic levels; integrated circuits at the logic level	2	Lecture and explanation; heuristic conversation; demonstration and exemplification; problem-based learning; guided	Teaching is supported by multimedia presentations, a projector, and the blackboard. A dedicated Microsoft Teams team
2. Boolean algebra and canonical forms: Boolean variables and functions; fundamental identities; De Morgan's theorems; truth tables; canonical sum-of-products and product-of-sums forms; conversion between different representations.	2		
3. Logic-gate implementation of Boolean functions: Implementation of canonical forms using NOT–AND–OR and	2		

9.1 Lecture	No. of hours	Teaching methods	Remarks
NOT–OR–AND structures; NAND-only and NOR-only implementations; XOR and XNOR functions; gate-level implementation cost.		exercises; case studies; formative assessment and feedback.	and its associated SharePoint space are used for communication and distribution of electronic materials, including lecture slides, handouts, solved examples, assignments, and supplementary resources. Microsoft OneNote is used, when appropriate, as a digital whiteboard.
4. Logic minimization and hazard-aware design: Karnaugh maps; minimal SOP and POS forms; Boolean-expression factoring; comparison of alternative implementations; propagation-delay effects; static hazards and glitches; hazard elimination.	2		
5. Multiplexers and demultiplexers: Multiplexer and demultiplexer operation; enable and selection inputs; cascading and capacity extension; multiplexers as universal logic elements; implementation of Boolean functions using multiplexers.	2		
6. Decoders and encoders: Binary decoders; enable inputs; decoder cascading and capacity extension; implementation of Boolean functions using decoder–OR structures; encoders and priority encoders; code-conversion and selection applications.	2		
7. Combinational-circuit design examples: Analysis, synthesis, and implementation of the majority-voting function; binary comparators; parity generators and checkers.	2		
8. Sequential-logic fundamentals: Differences between combinational and sequential circuits; SR and D latches; D, JK, and T flip-flops; level-sensitive and edge-triggered operation; synchronous and asynchronous inputs.	2		
9. Finite-state machines—specification and synthesis: Sequential circuits modeled as finite-state machines; state diagrams and state tables; Moore and Mealy models; state assignment and encoding; binary and one-hot encoding; derivation of next-state and output functions.	2		
10. Finite-state-machine implementation: State register, next-state logic, and output logic; implementation using flip-flops and combinational logic circuits; sequence detectors; pulse and pattern generators; output glitches and synchronous output registration.	2		
11. Registers and register-transfer structures: Multi-bit registers; parallel loading and enable; synchronous and asynchronous reset; register-transfer operations; serial and parallel data transfer; SISO, SIPO, PISO, and PIPO structures.	2		

9.1 Lecture	No. of hours	Teaching methods	Remarks
12. Shift-register applications and sequence generation: Shift-register cascading and capacity extension; serial-to-parallel and parallel-to-serial conversion; register-plus-combinational-logic structures; pattern and signal generators.	2		
13. Synchronous counters: Binary up, down, and up/down counters; synchronous-counter structures; modulo-(N) counters; truncated counting sequences; counter cascading and capacity extension; terminal-count detection; frequency division.	2		
14. Counter-based digital systems: Counter-plus-decoder and counter-plus-combinational-logic structures; counters modeled as finite-state machines; programmable signal and pattern generators.	2		

Bibliography:

1. S Hintea, G Csipkes, D Csipkes, P Farago, M Cirlugea:Digital Integrated Circuits, Casa Cartii de Stiinta, Cluj-Napoca, 2017;
2. M. Cîrlugea: DIC Course notes;
3. Paul Farago, Botond Kirei, Gabor Csipkes, Sorin Hintea - DESCRIEREA IN VHDL A SISTEMELOR CU CIRCUITE INTEGRATE DIGITALE - Indrumator de Proiectare si Simulare. Editura U.T.PRESS, Cluj-Napoca, 2014;
4. S. Hintea, Lelia Feştilă, Mihaela Cîrlugea – Circuite Integrate Digitale.UT Press, 2005;
5. Gabor Csipkes, Doris Csipkes, Sorin Hintea, Mihaela Cîrlugea - "Circuite integrate digitale: culegere de probleme", editura UT Press 2011;
6. Lelia Feştilă – Electronică digitală - Circuite logice secvenţiale, Lito, UTC-N, 1994;
7. S. Hintea, Lelia Feştilă, Mihaela Cîrlugea – Circuite Integrate Digitale. Culegere de probleme, Ed. Casa Cărţii de Ştiinţă, 1999;
8. J. Wakerly – Digital Design, Principle & Practices, Prentice Hall, 1999;
9. S. Hintea, Lelia Feştilă, Mihaela Cîrlugea – Circuite Integrate Digitale. Culegere de probleme, Ed. Casa Cărţii de Ştiinţă, 1999;
10. Dan Nicula. Electronica digitala. Carte de invatatura. Editura Universităţii TRANSILVANIA din Braşov, 2012;
11. A.E.A. Almaini. Electronic Logic Systems, Ed. Prentice Hall, 1994;
12. http://bel.utcluj.ro/ci/rom/cid/index.html

9.2 Seminar /laboratory /project /practical training	No. of hours	Teaching methods	Remarks
Seminar		Problem-solving; heuristic conversation;	Practical activities use digital
1. Boolean algebra and canonical forms	2		
2. Design of logic functions using gates	2		

9.2 Seminar /laboratory /project /practical training	No. of hours	Teaching methods	Remarks
3. Design of logic functions using multiplexers and demultiplexers	2	individual and group exercises; demonstration; guided educational experimentation; simulation-based analysis; teamwork; formative assessment and feedback.	integrated circuits, testing and prototyping boards, electronic measurement instruments, hardware description languages, and FPGA development boards. Materials are distributed through Microsoft Teams and SharePoint.
4. Decoders and encoders	2		
5. Sequential circuits using flip-flops	2		
6. Circuits with shift-registers	2		
7. Circuits with counter	2		
Laboratory			
1. Elementary logic gates—implementation on a prototyping board	2		
2. Elementary logic gates—HDL description and simulation	2		
3. Multiplexers, demultiplexers, and decoders—implementation on a prototyping board	2		
4. Multiplexers, demultiplexers, and decoders—HDL description and simulation	2		
5. Flip-flop circuits—implementation on a prototyping board	2		
6. Flip-flops, registers, and counters—HDL description and simulation	2		
7. Laboratory assessment and make-up session	2		

Bibliography:
1. Paul Farago, Botond Kirei, Gabor Csipkes, Sorin Hintea – Descrierea in VHDL a sistemelor cu circuite integrate digitale - Indrumator de Proiectare si Simulare. Editura U.T.PRESS, Cluj-Napoca, 2014.
2. Gabor Csipkes, Doris Csipkes, Sorin Hintea, Mihaela Cîrlugea - "Circuite integrate digitale: culegere de probleme", UT Press 2011.
3. ROTH, Charles H., Jr.; JOHN, Lizy Kurian. *Digital Systems Design Using VHDL*. 2nd ed. Thomson Learning, 2008. ISBN 978-0-534-38462-3.
4. JOHN, Lizy Kurian; ROTH, Charles H.; LEE, Byeong Kil. Digital Systems Design Using Verilog. 1st ed. Cengage Learning, 2015. ISBN 978-1-305-12074-7.
5. M Cirlugea, S Hintea, Introducere in VHDL, Casa Cartii de Stiinta, 1999;
6. http://bel.utcluj.ro/ci/rom/cid/index.html

10. Alignment of the course contents with the expectations of the epistemic community, professional associations, and representative employers in the field related to the program

The course content and the teaching-learning-assessment methods are aligned with the current requirements of the Electronics, Telecommunications, and Information Technology Engineering field, considering the expectations of the academic and professional community, representative employers, as well as the national quality assurance standards in higher education. The course helps prepare students in line with employer expectations and the quality requirements set for engineering study programs.

11. Assessment

Activity type	**11.1 Assessment criteria**	**11.2 Assessment methods** (and type of assessment: continuous/ summative)	**11.3 Weight in final grade**
11.4 Lecture	Understanding and correct use of Boolean algebra and minimization methods; analysis and design of combinational and sequential circuits; specification and implementation of finite-state sequential machines using flip-flops, shift registers, and counters.	Summative assessment – written examination (E), consisting of theoretical questions and analysis, synthesis, design, and calculation problems.	E: 70%
11.5 Seminar/ Laboratory/ Project /Practical activity	Laboratory: Correct implementation, simulation, and verification of digital circuits; use of laboratory instruments, HDL environments, and FPGA boards; interpretation of experimental and simulation results; identification and correction of connection, description, and functional errors.	Laboratory (L): Continuous assessment – evaluation of practical activities, experimental and simulation results, and the laboratory test.	L: 30%

11.6 Minimum performance standard

Written examination – $E \geq 5$, The minimum requirements for obtaining grade 5 are:

- correct representation and minimization of a low-complexity logic function;
- analysis and design of a combinational circuit;
- analysis and design of a sequential circuit;
- interpretation of the operation of fundamental registers and counters.

Laboratory – $L \geq 5$, The minimum requirements for obtaining grade 5 are:

- correct solution of fundamental Boolean-algebra and logic-minimization problems;
- derivation of operating equations for simple combinational and sequential circuits;
- preparation of state diagrams and state tables for low-complexity finite-state machines;
- elementary design of registers and counters.

Attendance at all laboratory activities is compulsory. All required practical activities must be completed. Any missed activities must be completed during the designated make-up sessions.

If $E \geq 5$ and $L \geq 5$, the final grade is calculated using the expression:

$$0.7 \cdot E + 0.3 \cdot L$$

Completion date:	**Course coordinators**	**teaching rank, title First name LAST NAME**	**Signature**
23.06.2026	Lecture	Assoc.prof. Mihaela CÎRLUGEA, Ph.D.	
	Applications	Assoc.prof. Mihaela CÎRLUGEA, Ph.D.	
		Assoc.prof. Paul FARAGÓ, Ph.D.	

Approval of the Head of the Department coordinating the course, only if this differs from the department organizing the study program	Head of the Department

Date of approval by the Council of the Department of Bases of Electronics 26.06.2026	Head of the Bases of Electronics Department Prof. Sorin HINTEA, Ph.D.
Date of approval by the Council of the Faculty of Electronics, Telecommunications and Information Technology 30.06.2026	Dean, Prof. Ovidiu-Aurel POP, Ph.D.