(*faculty stamp*)

Z1-PU7	WYDANIE N1	Strona 1 z 3

COURSE DESCRIPTION

1. Course title: DIGITAL CIRCUITS	**2. Course code DC**
3. Validity of course description: 2016/2017	
4. Level of studies: BA, BSc programme (1st cycle of higher education)	
5. Mode of studies: intramural studies / ~~extramural studies~~	
6. Field of study: Control, Electronic and Information Engineering (CEIE)	(FACULTY SYMBOL) RAu
7. Profile of studies: general	
8. Programme: all	
9. Semester: 4	
10. Faculty teaching the course: Institute of Electronics, (RAu-3)	
11. Course instructor: Adam Milik (PhD)	
12. Course classification: common subjects	
13. Course status: compulsory /~~elective~~	
14. Language of instruction: English	
15. Pre-requisite qualifications:	

16. Course objectives:

Course is a part of specialized curriculum content and covers basics of digital hardware design. The course objectives include having the students got acquainted with available hardware component base, methods of implementing a specified functionality in hardware and related design methodologies and tools.

17. Description of learning outcomes:

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1.	Has knowledge of design methodologies of digital systems implemented in basic technologies including programmable technologies (PLD, FPGA) and their interaction and impact on environment	test, laboratory tasks	lecture, class, laboratory	K_W4
2.	Has knowledge of arithmetic principles of logic circuits, designing and operation of logic combinatorial, sequential and microprogrammable circuits	test, laboratory tasks	lecture, class, laboratory	K_W10
3.	Is familiar with and understood methodologies of designing electronics circuits including control systems. Is able to use CAD/CAE software in design and verification process	laboratory tasks	laboratory	K_W17
4.	Is able to obtain information from literature and other data sources. Is able to interpret them.	test, laboratory tasks	lecture, class, laboratory	K_U1
5.	Is able to work independently and in team	test, laboratory tasks	lecture, class, laboratory	K_U2
6.	Is able to design and assembly digital systems	test, laboratory tasks	lecture, class, laboratory	K_U12
7.	Is able to use CAD/CAE software	laboratory tasks	Lecture, laboratory	K_U24
8.	Understands necessity of continues learning	test, laboratory tasks	lecture, class, laboratory	K_K1
9.	Is able to work in group, takes up different goals	laboratory tasks	laboratory	K_K3

18. Teaching modes and hours

Lecture: 30h, Class: 15h, Laboratory: 15h

19. Syllabus description:

Lecture:

Basic information about digital signals: quantization and coding, binary codes, binary coded decimal numbers (BCD), fixed point positive and negative numbers, symbolic data representation.

General description of digital integrated circuits: scale of integration, digital circuits families

Introduction to implementation of logic components in different technologies from RTL (Resistor-Transistor-Logic), TTL (Transistor-Transistor-Logic), MOS transistor and implementation of P-MOS/N-MOS/C-MOS logic components an overiview. C-MOS technology – short overview of manufacturing. CMOS components. Specific components implementation: NAND, NOR, AOI, transmission gate, flip-flops, muxes.

Introduction to Verilog HDL. Difference between program (sequential algorithm) and parallel description. Methods of describing combinatorial and sequential blocks. All following issues are illustrated with synthesizable patterns of HDL code.

Combinatorial circuits implementation theory and implementation with use of multiplexers, decoders and lookup tables. Basics of function expansion and decomposition, Shannon expansion, BDD outline, Ashenhurst-Curtis decomposition theorem.

Sequential circuits: basic flip-flip types (D, T, JK), building excitation functions for respective flip-flop type.

Counters: asynchronous counters, synchronous counters, basics of operation and synthesis, assessment of maximal clock frequency, control units with counters, hazards in counters, synthesis of counter units

Shift registers: design, counting registers ring, Johnson, LFSR, design of custom counting register, application in counting, data form conversion, diagnostics, data integrity check

Arithmetic circuits: fundamentals of natural and integer number representation and operations, adder – ripple carry adder, design, properties assessment, carry look ahead adder, BCD adder, multiplier – combinatorial implementation, sequential implementation, mixed approach; Conversion between BCD (or other custom radix) and Binary representation parallel and serial implementations.

Control unit design. Introduction to microprogrammable circuits as systematic method of control unit design,. methods of reducing ROM size and its influence to unit architecture, developing an equivalent graph and its limitations, Implementing FSMs with use of programmable logic devices, PLA, PLE and PAL circuits, examples. methods of decomposition of FSM

Memories: architecture , implementation, SRAM, DRAM, SDRAM, memories based components stacks and fifos, memories expansion of word and capacity

Devices for data input keysa, matrix keyboards, Data output LED, 7-segment displays in LED and LCD, display control methodology.

Data transmission: structure of digital system, asynchronous serial and parallel transmission, handshaking, bus protocol, long transmission lines: effects and line termination

Analog to digital converters: signal conversion method: flash, successive approximation, double integration, conversion errors, accuracy, noise dumping

Digital to analog basic structures, conversion accuracy and error definitions

Class:

Logic components: TTL, C-MOS components, architecture and electrical properties, equivalent linear models, driving indicators, relays, and other loads, interaction with resistors and capacitors, calculating of threshold voltages, time dependencies, transient manual circuit analysis, generators

Logic functions implementation and decomposition with use of multiplexer, decoders, lookup tables (basics of FPGA architecture)

Register and counters: architectures, shift registers, shift-parallel registers, designing custom counters and registers, counting register, cycle self-adjustment, dynamic properties

Arithmetic circuits – basic of arithmetic circuits, adder, addition and subtraction units for two’s and one’s complement system, multipliers, code converters (BCD – Bin) parallel and serial

Microprogrammable logic circuits, architecture, graph transformations, implementation, interacting with counters, sequential dependencies between machines

Designing digital circuit with FPLA, PLA, PLE, PAL devices.

Laboratory:

Static and Dynamic Gate Characteristics

Arithmetic Circuits

Microprogrammable Logic Circuits

Digital Frequency Meter

Analog to digital converters – integral converters

20. Examination: (no exam assigned)

21. Primary sources:

1. Jerry D. Daniels, Digital Design from Zero to One, John Wiley & Sons, 1996
2. John P. Hayes, Digital Logic Design, Addison Wesley, 1993
3. M. Morris Mano, Charles R. Kime Logic and Computer Design Fundamentals.
4. Samir Palnitkar, Verilog HDL, SunSoft Press 1998

22. Secondary sources:

1. M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL 5/E, Prentice Hall, 2012
2. Peter Ashenden, Digital Design, Academic Press , 2007
3. Frank Vahid Digital Design with RTL Design, Verilog and VHDL, 2nd Edition, John Wiley & Sons, 2010
4. John F. Wakerly, Digital Design: Principles and Practices, 4/E, Prentice Hall, 2006
5. Thomas L. Floyd, Digital Fundamentals, 10/E, Prentice Hall, 2009
6. Józef Kalisz, Podstawy elektroniki cyfrowej, wydanie 5 zm., WKiŁ, 2008 (in Polish)

23. Total workload required to achieve learning outcomes

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	30 / 20
2	Classes	15 / 15
3	Laboratory	15 / 15
4	Project	/
5	BA/ MA Seminar	/
6	Other	/
	Total number of hours	60 / 50

24. Total hours:110

25. Number of ECTS credits: 5

26. Number of ECTS credits allocated for contact hours:1

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 4

26. Comments:

Approved:

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(date, Instructor's signature)

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(*date , the Director of the Faculty Unit signature)*