### COURSE DESCRIPTION

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

#### 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 overview. 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.


Sequential circuits: basic flip-flop 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

22. Secondary sources:

23. Total workload required to achieve learning outcomes

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

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:

................................. ..............................................................
(date, Instructor’s signature) (date, the Director of the Faculty Unit signature)