1. **Course title:** MICROPROCESSORS

2. **Course code:** MS

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:** 5

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:**
Course attendants are supposed to have general knowledge of digital circuits operation, digital systems design, logic circuits implementation algorithms, basics of programming languages, algorithm development and implementation, principles of computer operation. Students are also supposed to possess practical skills concerning programming and algorithm implementation with use of high level programming language.

16. **Course objectives:**
Microprocessor architecture and its operation, instruction execution, bus architecture, interrupt system,
Microprocessor system architecture, interaction with memory and peripheral components, interrupt system concept and implementation, programming with use of assembly language and high level languages.
Implementation of numerical calculations and its performance, selected numerical algorithms (Bresenham, Newton-Raphson, CORDIC) Basics of serial interfaces, serial data transfer concepts and implementation, Basics of compilers and automatic recognition of sentences, high level languages from compiler (automatic tools) point of view Practical aspects of design and implementation of embedded systems, programming and debugging, on chip debug systems, design of custom peripherals, system integration, simulation and modelling of systems

17. **Description of learning outcomes:**

<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 arithmetic principles of logic circuits, designing and operation of logic sequential and microprogrammable circuits and embedded systems</td>
<td>Test, laboratory task, project</td>
<td>lecture, laboratory, project</td>
<td>K_W10</td>
</tr>
<tr>
<td>2.</td>
<td>Knows fundamental data structures and is able to select appropriate one for given problem</td>
<td>test, laboratory task, project</td>
<td>lecture, laboratory, project</td>
<td>K_W12</td>
</tr>
<tr>
<td>3.</td>
<td>Has knowledge of computer systems architecture, embedded systems and implementation of simple computer systems</td>
<td>Test, laboratory task, project</td>
<td>lecture, laboratory, project</td>
<td>K_W14</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, project</td>
<td>lecture, laboratory, project</td>
<td>K_U1</td>
</tr>
<tr>
<td>5.</td>
<td>Is able to analyze algorithms and estimate their complexity</td>
<td>test, project</td>
<td>lecture, laboratory, project</td>
<td>K_U11</td>
</tr>
</tbody>
</table>
### 18. Teaching modes and hours

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Laboratory</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>15h</td>
<td>30h</td>
<td>15h</td>
</tr>
</tbody>
</table>

### 19. Syllabus description:

**Lecture:**
- Introduction to microprocessors. Evolution from finite state machine through the microprogrammable device to microprocessor. Basic functional blocks of microprocessor and its features. Architecture influence to behavior and performance of computing system.
- Instruction set. Argument addressing, memory model and addressing modes, memory protection and virtualization.
- Interrupt system. Implementation concept. Classification of interrupt systems. Concept of vector interrupt system.

**Class:**

**Laboratory:**
- Introduction to HDL logic synthesis and FPGA technology. Implementation of peripheral devices. Creating and using bus functional models in verification. Binding the custom peripheral device with high level programming language.

**Projects:**
1. Implementation of mundane devices like advanced alarm clocks, timers, cycle computers etc. Students are supposed to implement software layer of the project that binds together simple hardware devices like displays, keyboards and other sensors into fully functional system. The attention is paid to simplicity of use and correct user interface simplicity.
2. Implementation of custom hardware device that supports operation of main design problem. Usually it is a specialized interface unit or arithmetic operation support device. Important part of the design concerns creating, modeling, synthesizing, implementing the device and linking it with microprocessor. The hardware component is linked with software operating by preparing appropriate declaration and drivers. Finally the component is used inside the design to proof its functionality.

**Examination:** (no exam assigned)

### 21. Primary sources:
- M. Morris Mano Computer System Architecture
- Steven Furber ARM System-on-chip Architecture
- Niklaus Wirth Algorithms + Data Structures = Programs
- Brian W Kernighan, Dennis M. Ritchie The C Programming Language
22. Secondary sources:
Samir Palnitkar, Verilog HDL, SunSoft Press 1998
Jean-Pierre Deschamps, Gery J.A. Bioul, Gustavo D. Sutter Synthesis of Arithmetic Circuits: FPGA, ASIC and Embedded Systems

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>15 / 15</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>0 / 0</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>30 / 15</td>
</tr>
<tr>
<td>4</td>
<td>Project</td>
<td>15 / 30</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 / 60</td>
</tr>
</tbody>
</table>

24. Total hours: 120

25. Number of ECTS credits: 4

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

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 3

26. Comments:

Approved:

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