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| **WSB UNIVERSITY Branch/Department of Jaworzno**  |
| **Field of study: Computer Science**  |
| **Module / subject: Computer Architecture**  |
| **Educational profile: practical**  |
| **Level of education: undergraduate studies**  |
| **Number of hours per semester**  | 1  | 2  | 3  | 4  |
| I  | II  | III  | IV  | V  | VI  | VII  |
| **Full-time studies** (w/w/lab/pr/e)\*  |   | **16w / 16lab**  |   |   |  |   |   |
| **Part-time studies** (w/æw/lab/pr/e)  |   | **12w / 12lab**  |   |   |  |   |   |
| **LANGUAGE OF** **INSTRUCTION**  | Polish  |
| **LECTURER**   | D. Eng. Badura Dariusz, Prof. AWSB, M.Sc. Kuśnierczyk Łukasz  |
| **FORM OF ACTIVITIES**  | Lecture, laboratory, consultation   |
| **SUBJECT** **OBJECTIVES**   | The aim of the course is to familiarise students with the most relevant concepts related to the architecture and organisation of modern computers and the directions of development in this area. An important objective of the course is also to present and give practical demonstrations in the basic scope of RISC-type architecture on the example of microcontrollers used in embedded systems, including Internet of Things (IoT) modules, with regard to the operation of the central unit, different types of memory, access to it and input-output devices. During the course, students are also introduced to the architecture of multicore computers, parallel computers and pipelined processing.   |
| **Reference to learning outcomes**  | **Description of learning outcomes**  | **Means of verification of the effect learning**  |
| **Directional effect**  | **PRK**  |
| **NEWS**  |
| INF\_W02  | P6S\_WG, P6S\_WG\_INZ  | Has knowledge of the basic types of computer architecture, Knows the features of the basic types of processors: CISC and RISC Understands the operation of computer peripheral circuits and systems such as interrupts, timers and counters, and direct access to computer memory (DMA) Knows the structure of typical microcontrollers, used in embedded systems including the Internet of Things IoT, with peripheral circuits, using selected families of programmable electronic circuits as an example.  | Exam - knowledge test,   |
| INF\_W03  | P6S\_WG, P6S\_WG\_INZ  | Students will have knowledge of the design and operation of computer systems, the functioning of individual computer blocks and their interaction with each other.  | Presentation of a report on the laboratory task including a description of the task carried out and the conclusions drawn from it.   |
| INF\_W01  | P6S\_WG,   | The student has a structured, knowledge covering issues forming the theoretical foundations of computer science, digital circuit structures and computer system architectures.  | Open test of knowledge gained in the lecture   |
| INF\_W03  | P6S\_WG,  | The student has a detailed knowledge of  | Presentation of the task report.  |

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|  | P6S\_WG\_INZ  | internet technologies, the possibilities for their use and development, and relates this to professional activities related to information technology.  |   |
| **SKILLS**  |
| INF\_U02 INF\_U14  | P6S\_UW P6S\_UW, P6S\_UW\_INZ  | The student uses the accumulated knowledge to create systems using the known elements of computer architecture, including the ability to effectively use the interrupt mechanism, counters and timers, handle I/O ports, peripherals, A/D converters, selected serial transmission protocols.  | Examination, knowledge test, Discussion, presentation, laboratory exercise reports.  |
| INF\_U05 INF\_U15  | P6S\_UO P6S\_UW P6S\_UW\_INZ   | Students will be able to plan and carry out experiments, including measurements and computer simulations, interpret the obtained results and draw conclusions while identifying and formulating specifications of engineering tasks and solving them: - use analytical, simulation and experimental methods, - recognise their systemic and non-technical aspects, including ethical aspects  | Execution of programmes to perform simple calculations and communication in a microprocessor system   |
| INF\_U13 INF\_U11  | P6S\_UW, P6S\_UW\_INZ   | The student is able to analyse the way IT systems function and evaluate their structure and organisation, and is able to administer simple computer systems. They will be able to analyse critically how existing technical solutions function and evaluate these solutions when identifying and formulating specifications for engineering tasks and solving them.   | Performing a task to write a programme using computer resources.   |
| INF\_U16  | P6S\_UO  | The student is able to work in a team during the laboratory exercises.  | Observation of students during classes  |
| **SOCIAL COMPETENCES**  |
| INF\_K401  | P6S\_KK  | He is aware of the need to continuously improve his knowledge in the dynamically developing field of computer systems architecture, being able to critically assess his own preparation for a specific task, Is aware of the importance of group work, proper communication in the laboratory section and the importance of contact with experts in electrical and electronic engineering when consulting in the analysis of a problem/task. Based on the knowledge acquired, he is able to selectively and consciously use the large amount of available teaching material in electronic and traditional form.  | Argumentative discussion during class and when evaluating reports and assignments.  |
| INF\_K401  | P6S\_KK  | The student is ready to critically evaluate his/her knowledge and perceived content concerning the achievements of computer science, to recognise the importance of knowledge in solving cognitive and practical problems, and to consult experts in case of difficulties in solving a problem independently.  | Report on the solution of a laboratory task on a computer with limited hardware resources and the conclusions of the solution.   |
| INF\_K02 INF\_K03  | P6S\_KR  | The student is prepared to resolve dilemmas related to the IT profession by observing the  | Argumentative discussion during class and when evaluating reports  |

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|  |  | principles of professional ethics and requiring others to do so while maintaining a concern for the traditions and development of the profession.  | and assignments  |
| **Student workload (in teaching hours 1h =45 minutes)\*\***  |
| **Stationary Part-time** attendance at lectures = 16 attendance at lectures = 12 participation in exercises/laboratories = 16 participation in exercises/laboratories = 12 Preparation for exercises/laboratory = 30 Preparation for exercises/laboratory= 32 lecture preparation = 20 lecture preparation = 26 exam preparation/assessment = 10 exam preparation/assessment= 10 implementation of project tasks = implementation of project tasks = e-learning = e-learning = Pass/examination = 4 Pass/examination = 4 other (consultation) = 4 other (consultation) = 4 **TOTAL: 100h TOTAL: 100h** **Number of ECTS credits: 4 Number of ECTS credits: 4** **including in practical classes: 2 including in practical classes: 2**  |
| **PREREQUISITES**  | Knowledge of mathematics and physics with elements of electrical circuits.  |
| **SUBJECT** **CONTENT** (broken down into face-to-face and elearning classes)  | Content delivered in a face-to-face format: Lecture: * Historical outline of the development and evolution of computer architecture. Technological generations and the organisation of computers.
* Summary of knowledge of digital technology in the context of its use in describing the elements of computer architecture: elements of Boolean algebra, logic gates (AND, OR, NOT, NAND, NOR, XOR), flip-flops, registers, counters, arithmetic circuits (half adder, adder), encoders, decoders, multiplexers, demultiplexers, ROM, introduction to PLD (Programmable Logic Device).
* Summary of knowledge of number systems, representation of numbers in computer systems and computation on them. Fixed-point and floating-point arithmetic.
* Discussion and comparison of the von Neumann type of architecture and the HARVARD type of architecture
* CISC (Complex Instruction Set Computers) and RISC (Reduced Instruction Set Computers) processor types
* Memory organisation, protection and access methods. Virtual memory. External memories. Bus and access methods.
* Timing and counter systems,
* Interrupt system. Maskable and non-maskable interrupts.
* Design of the CPU and processor peripherals using the family as an example AVR (ATMega) (single chip microcontroller)
* Introduction to programming using the AVR family microcontrollers as an example. • Introduction to local serial buses,
* Pipelined Datapath processing.
* Multiprocessor systems. Topologies of multiprocessor systems. Problems of computational parallelization. Multi-computer systems.

 Lab:  * 1. von Neuman and Harvard architecture; history of computer development; 8080
		1. von Neuman architecture vs. Harvard architecture;
		2. Bus architecture: types of computer bus bars
		3. The role of the processor in computer architecture: computer versus embedded system (microcontroller)
		4. Structure of simple microprocessors
	2. Binary arithmetic, binary number notation;
		1. Types of binary information records, including numbers: ASCII code,
		2. Fixed and floating point notation; standard for real number notation
		3. Arithmetic operations in the processor - markers , marker register
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|  |  d. Octal and hexadecimal notation of data in computer memory 1. 8086 microprocessor - basic mechanisms argument addressing
	1. Memory addressing of a 16-bit microprocessor: logical address, physical address b. Memory paging mechanism
	2. Argument addressing types: immediate, direct, indirect, index-based
	3. Microprocessor command design
	4. Addressing of input and output circuits
2. 8086 Command fetch and execute process - command list
	1. Designation of the physical address
	2. List of orders;
	3. MMX and SEE technologies
	4. CISC vs. RISC architecture
3. Interruptions
	1. Maskable and unmaskable interruptions
	2. Interruption reporting and handling process
	3. Prioritisation of interrupts
	4. Software interrupts, thread handling
4. Addressing principles in microprocessors: physical address , logical address; address descriptors
	1. Memory address space and physical, logical and page addresses
	2. Address descriptors
	3. Microprocessor cache
	4. Memory - construction
5. Real mode and protection mode; the concept of cores;
	1. The concept of real mode; Real modes of Pentium microprocessors
	2. Concept of protection mode; Principles of protection mode description in Pentium processors
	3. Core design of microprocessors
	4. Multiprocessor systems; Core design; Examples of cores
6. Parallel and serial transmission systems;
	1. Parallel transmission
	2. Synchronous and asynchronous types of serial transmission
	3. RS232 and USB transmission interfaces
	4. I2C and 1 wire transmission interfaces

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| **LITERATURE** **COMPULSORY**  | * J. Hennessy, Computer Architecture, Elsevier Science & Technology, 2017
* Stallings, W, Computer system organisation and architecture, PWN Scientific Publishers, 2022
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| **LITERATURE** **SUPPLEMENTARY** (including min. 2 items in English; book publications or articles)  | * BORKOWSKI P.: AVR and ARM7. Programming microcontrollers for everyone, ISBN Printed Book: 978-83-246-2628-1, Helion 2010.
* FRANCUZ T.: The C language for AVR microcontrollers. From basics to advanced applications, Print Book ISBN: 978-83-246-3064-6, Helion 2011.
* J. Glenn Brookshear, Computer science in general, WNT, Warsaw 2003
* HADAM P.: Design of microprocessor systems, BTC, Warsaw 2004.
* Hyde R., 'Professional programming volume 1 and 2 - Think low-level, write high-level', Helion, Gliwice 2006.
* KALISZ J.: Podstawy elektroniki cyfrowej, WKiŁ, Warszawa 2007
* M. Morris Mano, C. Kime, Fundamentals of logic circuit and computer design, WNT, 2007.
* Hennessy J. Patterson W., "Computer Architecture A Quantitative Approach", 3rd edition, Morgan Kaufmann Publishers, 2002
* PEŁKA R.: Mikrokontrolery - architektura, programowanie, zastosowania, WKŁ, Warszawa 2006.
* A.S. Tanenbaum, Structural organization of computer systems. Helion, 2006
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| **TEACHING** **METHODS** (broken down into face-to-face and elearning classes)  | Lecture using audio-visual means. Use of a blended-learning e-learning platform as a repository to provide students with lecture pdf scripts and supplementary material including index cards and application notes, links to interesting industry resources on the web. Use of the OnlineWSB moodle platform to provide students with lecture pdf scripts, laboratory instructions and supplementary material. Assignment type resource used to upload lab reports.  |
| **LEARNING AIDS**  | Lecture:  |
|  | Overhead projector, multimedia board, Demonstrations of the use of programming environments dedicated to the programming of a selected family of microcontrollers, using selected microcontrollers' evaluation boards as an example, . Lab: Algorithmics and low-level coding test environment with the ability to run simulations and step-by-step test runs of written programmes. Computer with integrated microprocessor system design and runtime installed.    |
| **PROJECT** (insofar as it is carried out as part of a course module)  | Not applicable  |
| **FORM AND** **CONDITIONS OF** **PASSING** (broken down into face-to-face and elearning classes)  | Lecture: Examination using the moodle OnLineWSB platform, using an open test resource. Laboratory: Pass mark - average of marks from completion of exercises and reports/reports uploaded to the resource Task of the OnLineWSB remote education platform.    |