

## Subject card

|                                             |                                                                                                                                                                                                                                                                                           |                                                          |                                                                                                                                                                    |                                     |                                                                                                                      |            |     |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------|------------|-----|
| Subject name and code                       | Automata, Languages and Computational Complexity, PG_00198472                                                                                                                                                                                                                             |                                                          |                                                                                                                                                                    |                                     |                                                                                                                      |            |     |
| Field of study                              | Informatics                                                                                                                                                                                                                                                                               |                                                          |                                                                                                                                                                    |                                     |                                                                                                                      |            |     |
| Date of commencement of studies             | October 2026                                                                                                                                                                                                                                                                              |                                                          | Academic year of realisation of subject                                                                                                                            |                                     | 2027/2028                                                                                                            |            |     |
| Education level                             | Bachelor's studies                                                                                                                                                                                                                                                                        |                                                          | Subject group                                                                                                                                                      |                                     | Obligatory subject group in the field of study<br>Subject group related to scientific research in the field of study |            |     |
| Mode of study                               | part-time studies                                                                                                                                                                                                                                                                         |                                                          | Mode of delivery                                                                                                                                                   |                                     | at the university                                                                                                    |            |     |
| Year of study                               | 2                                                                                                                                                                                                                                                                                         |                                                          | Language of instruction                                                                                                                                            |                                     | Polish                                                                                                               |            |     |
| Semester of study                           | 4                                                                                                                                                                                                                                                                                         |                                                          | ECTS credits                                                                                                                                                       |                                     | 5.0                                                                                                                  |            |     |
| Learning profile                            | academic                                                                                                                                                                                                                                                                                  |                                                          | Assessment form                                                                                                                                                    |                                     | exam                                                                                                                 |            |     |
| Conducting unit                             | Institute of Informatics -> Faculty of Mathematics, Physics and Informatics -> Rector                                                                                                                                                                                                     |                                                          |                                                                                                                                                                    |                                     |                                                                                                                      |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                                                                                                                                                        |                                                          | dr Andrzej Borzyszkowski                                                                                                                                           |                                     |                                                                                                                      |            |     |
|                                             | Teachers                                                                                                                                                                                                                                                                                  |                                                          |                                                                                                                                                                    |                                     |                                                                                                                      |            |     |
| Lesson types                                | Lesson type                                                                                                                                                                                                                                                                               | Lecture                                                  | Tutorial                                                                                                                                                           | Laboratory                          | Project                                                                                                              | Seminar    | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                     | 20.0                                                     | 20.0                                                                                                                                                               | 0.0                                 | 0.0                                                                                                                  | 0.0        | 40  |
|                                             | E-learning hours included: 0.0                                                                                                                                                                                                                                                            |                                                          |                                                                                                                                                                    |                                     |                                                                                                                      |            |     |
| Learning activity and number of study hours | Learning activity                                                                                                                                                                                                                                                                         | Participation in didactic classes included in study plan |                                                                                                                                                                    | Participation in consultation hours |                                                                                                                      | Self-study | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                     | 40                                                       |                                                                                                                                                                    | 0.0                                 |                                                                                                                      | 85.0       | 125 |
| Subject objectives                          | The aim of the course is to<br>1. introduce the basics of automata theory and formal languages, develop skills in manipulating regular expressions, and using context-free grammars,<br>2. introduce the concept of a Turing machine and basic complexity classes, P and NP               |                                                          |                                                                                                                                                                    |                                     |                                                                                                                      |            |     |
| Learning outcomes                           | Course outcome                                                                                                                                                                                                                                                                            |                                                          | Subject outcome                                                                                                                                                    |                                     | Method of verification                                                                                               |            |     |
|                                             | [INFOL3_W03] knows and understands advanced concepts in the field of algorithms and data structures, formal languages, automata theory and computational complexity, and artificial intelligence                                                                                          |                                                          | is familiar with the basics of automata theory and formal languages<br>is familiar with the concept of a Turing machine and the basic complexity classes, P and NP |                                     | [SW4] test/exam - oral or written                                                                                    |            |     |
|                                             | [INFOL3_U06] is able to select and apply appropriate IT methods and tools to solve complex problems, is able to use acquired knowledge by appropriately selecting sources and information derived from them, and perform evaluation, critical analysis, and synthesis of this information |                                                          | can work with regular expressions and use context-free grammars                                                                                                    |                                     | [SU2] presentation/project/paper/report<br>[SU4] test/exam - oral or written                                         |            |     |
|                                             | [INFOL3_U02] is able to use his/her knowledge of higher mathematics to model and solve complex problems                                                                                                                                                                                   |                                                          | can work with regular expressions and use context-free grammars                                                                                                    |                                     | [SU2] presentation/project/paper/report<br>[SU4] test/exam - oral or written                                         |            |     |

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|----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Subject contents                                               | <ul style="list-style-type: none"><li>• Finite automata, regular expressions, non-deterministic automata, the determinization theorem, the equivalence theorem for finite automata and regular expressions, the pumping lemma,</li><li>• Chomsky grammars, context-free grammars, pushdown automata, derivation trees. The pumping lemma for context-free languages, context-sensitive grammars, and linearly bounded automata,</li><li>• Turing machines, recursive and recursively enumerable languages, decidable and undecidable problems, the halting problem</li></ul> |                                                                                                                                                                                                                                            |                               |
| Prerequisites and co-requisites                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                            |                               |
| Assessment methods and criteria                                | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Passing threshold                                                                                                                                                                                                                          | Percentage of the final grade |
|                                                                | tests                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 51.0%                                                                                                                                                                                                                                      | 60.0%                         |
|                                                                | exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 51.0%                                                                                                                                                                                                                                      | 40.0%                         |
| Recommended reading                                            | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | lecture notes available at WWW webpage                                                                                                                                                                                                     |                               |
|                                                                | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <ol style="list-style-type: none"><li>1. J. Jędrzejowicz, A. Szepietowski Języki, automaty, złożoność obliczeniowa Wyd. UG 2008;</li><li>2. J. Hopcroft, J. Ullman - Introduction to automata theory, languages and computation.</li></ol> |                               |
|                                                                | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                            |                               |
| Example issues/<br>example questions/<br>tasks being completed | <ul style="list-style-type: none"><li>• To which class does the sum of languages belong: regular, context-free, recursive, or recursively enumerable?</li><li>• Is the complement of the regular language also a regular one? What about context-free languages? Recursive languages?</li><li>• Is the language of palindromes regular? Is it context-free? Specify an appropriate automaton and/or grammar that recognizes this language.</li></ul>                                                                                                                         |                                                                                                                                                                                                                                            |                               |
| Work placement                                                 | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                            |                               |

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