| Study programme | Type of study (cycle) | Third cycle of studies – doctoral studies |
|---|---|---|
| | Name of the study programme | Doctoral Study in Mathematical and Computer Sciences |

**COURSE**

| Course title | **Complexity Theory** |
|---|---|

| Course code | Semester | Course status | ECTS credits | Contact hours |
|---|---|---|---|---|
| CS 660 | II | Elective | 10 | 30 |

**Course objectives and learning outcomes**

Introduction to advanced concepts of computability theory, with a special focus on the decidability of logical theories and the limits of what can be solved algorithmically.

In-depth understanding of the structure of space complexity classes and their mutual relationships through key theorems (Savitch's theorem, hierarchy theorems).

Study of alternative complexity measures and models of computation, including circuit complexity and algorithmic information theory.

Upon passing the course, the student will be able to: apply the recursion theorem and the concepts of Turing reducibility to prove (non)computability and analyze the complexity of algorithmic problems; analyze the decidability of logical theories and determine the formal limits of their algorithmic solvability; classify problems into the appropriate space complexity classes (L, NL, PSPACE) and evaluate their mutual relationships by applying Savitch's theorem; study the separation of complexity classes using the time and space hierarchy theorems, explain the formal definition of information (such as Kolmogorov complexity) and use it in the context of computability analysis, relate circuit complexity to standard Turing models of computation and estimate hardware lower bounds for solving problems.

Course content

- The recursion theorem.
- Decidability of logical theories.
- Turing reducibility.
- Definition of information.
- Savitch's theorem.
- The classes PSPACE, L, NL.
- Hierarchy theorems.
- Circuit complexity.

**LITERATURE**


[1] Lewis, H. and Papadimitriou, C., Elements of the theory of computation, Prentice Hall, 2nd ed. 1998.
[2] Sipser, M., Introduction to the Theory of Computation, PWS Publishing Company, 1997.
[3] Sommerhalder, R., Van Westrhenen S. C., The Theory of Computability: Machines, Effectiveness and Feasibility, Addison Wesley, 1987.
[4] Sanjeev Arora and Boaz Barak, Computational Complexity: A Modern Approach, Cambridge University Press, 2009.


**ASSESSMENT AND GRADING**

| | Criterion | Points | Requirement |
|---|---|---|---|
| 1. | Homework assignments | 30 | |
| 2. | Project | 30 | |
| 3 | Final exam | 40 | |
| | T o t a l | 100 | 55 |