ÖREBRO UNIVERSITET

Course syllabus
Third-cycle courses and study programmes

Computational Complexity Theory, 3 credits

Beräkningskomplexitetsteori, 3 hp

Course Code/Codes	50DT041
Subject Area	Computer Science (Datavetenskap)
School/equivalent	School of Science and Technology (Institutionen för naturvetenskap och teknik)
Valid from	2016-12-15
Approved	2016-12-15
Revised	
Approved by	Head of School Peter Johansson
Translation to English, date and signature	

1 Course content

This course examines the basic principles of complexity theory. It refreshes the basics of algorithm analysis (the analysis of resource usage of given algorithms) and of the principal formal properties of algorithms (correctness, completeness, optimality). Specifically, it gives an overview of the principal notations and methods for characterizing non-recursive and recursive algorithms. The course also provides an overview of the main issues problem complexity, that is, the study of the cost of solving interesting problems, given a suitable model of computation. Within this topic, we overview the principal models of computation used to characterize problem complexity (e.g., Turing Machines), their equivalence to computable functions (Church-Turing Thesis), and the principal problem complexity classes (NL, LOG, P, NP, PSPACE, EXPTIME, EXPSPACE).

2 Outcomes

2.1 The course in relation to the doctoral programme

The course shall primarily refer to the following intended learning outcomes for third-cycle courses and study programmes as described in the Higher Education Ordinance, i.e. the doctoral student shall demonstrate:

Knowledge and understanding
- broad knowledge and systematic understanding of the research field (part of outcome 1)
- advanced and up-to-date specialised knowledge in a limited area of this field (part of outcome 1)
- familiarity with the methods of the specific field of research in particular (part of outcome 2)

Competence and skills
- the capacity for scholarly analysis and synthesis (part of outcome 3)
- the capacity to review and assess new and complex phenomena, issues and situations autonomously and critically (part of outcome 3)

- the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively (part of outcome 4)

The intended learning outcomes are listed in the same order as in the general syllabus for the programme.

2.2 Intended course learning outcomes

To obtain a passing grade, the doctoral student shall demonstrate:

Knowledge and understanding
- understanding of the difference between algorithm complexity and the computational complexity of problems;
- understanding of the general principles by which complexity analysis of algorithms can be carried out;
- understanding of the main formal properties of algorithms (completeness, correctness, optimality)
- knowledge of the principal problem complexity classes in the polynomial hierarchy
- understanding of the general methods used to prove membership in a particular problem complexity class
- knowledge of the computational complexity classification of important recurring problems in computer science, robotics and AI (k-SAT, Hamiltonian cycle, Ord-Horn formulae, resource scheduling, motion and task planning problems, etc.)

Competence and skills
- ability to compute bounds on the time complexity of an algorithm
- ability to understand intuitively whether given decision problems require exponential computation
- ability to perform Karp-reductions of problems to other problems
- ability to prove whether given problems are in classes P, NP, PSPACE etc.,
- ability to prove P-/NP-completeness of problems

Judgement and Approach
- ability to evaluate intuitively the computational complexity of a problem presented in plain English, and
- an understanding of the factors that make the problem belong to a particular complexity class

3 Reading list and other teaching material

The following course readings and teaching material will be used on the course:

- Overheads/syllabus provided by the instructor
- Extra reading material in the form of research papers that are relevant to the student's specific research area and employ complexity analysis and/or computational complexity classifications

4 Teaching formats

Teaching on the course takes the following format:

Teaching will occur through seminars. Students will, as part of the examination, also give seminars to the class (see Examination below).

5 Examination

The course is assessed through an examination in the format of

A seminar where the student presents and discusses an analysis of the computational complexity of one or more problems that are relevant to the student's research area; alternatively, an analysis of the formal properties of an algorithm that is relevant to the student's research area.

6 Grades

Examinations on third-cycle courses and study programmes are to be assessed according to a two-grade scale with either of the grades 'fail' or 'pass' (local regulations).

The grade shall be determined by a teacher specifically nominated by the higher education institution (the examiner) (Higher Education Ordinance).

To obtain a passing grade on examinations included in the course, the doctoral student is required to demonstrate that he/she attains the intended course learning outcomes as described in section 2.2. Alternatively, if the course consists of multiple examinations generating credit, the doctoral student is required to demonstrate that he/she attains the outcomes that the examination in question refers to in accordance with section 5.

A student who has failed an examination is entitled to a retake.

If an examination consists of several examination components, and a student fails an examination component, the examiner may, as an alternative to a retake, set a make-up assignment with regard to the examination component in question.

A doctoral student who has failed an examination twice for a specific course or course element is entitled, upon his/her request, to have another examiner appointed to determine the grade.

7 Admission to the course

7.1 Admission requirements

To gain access to the course and complete the examinations included in the course, the applicant must be admitted to a doctoral programme at Örebro University.

7.2 Selection

Selection between applicants who have been admitted to doctoral programmes at Örebro University and who otherwise meet the admission requirements as listed above is made according to the following order of precedence:

If no other selection criteria are specified in this section, priority shall be given to applicants with a lower number of course credits left before the award of their degree over applicants with a higher number of remaining course credits. Should two or more students have equal number of credits, selection will be done through the drawing of lots. This also applies within any selection groups listed unless otherwise stated.

7.3 Other applicants than doctoral students admitted at Örebro University

Other applicants than doctoral students admitted at Örebro University may be given access to the course on the grounds of provisions for and/or agreements regarding contracted courses, joint degrees, national graduate schools or cooperation in other respects with other universities.

Any decisions on what such other applicants may be given access to the course are made separately and on the basis of the provisions and/or agreements that occasion the student to apply for the course.

For participation in the course in other respects, the same provisions shall apply as for doctoral students admitted to Örebro University.

8 Transfer of credits for courses, study programmes and other experience

Provisions on the transfer of credits can be found in the Higher Education Ordinance and on the university's webpage.

9 Other information

The course is given in English.

Transitional provisions

None.