EUROPEAN MASTER'S PROGRAM IN COMPUTATIONAL LOGIC (EMCL) COURSE DESCRIPTION

Course title	**Principles of Computation**
Course code	74017
Scientific sector	ING-INF/05
Degree	European Master's Program in Computational Logic (LM-18)
Semester	1
Year	2
Credits	12
Modular	Yes
University	UniBZ

Attendance	Not compulsory
Prerequisites	There are no prerequisites in terms of courses to attend. Students should be familiar with notions of mathematics and set theory, and with basic proof techniques, as taught in the mathematics courses of a bachelor in computer science.
Course page	To be announced

Specific educational objectives	The course belongs to the type "A scelta della/o studente". The course is part of the advanced topics offered within the degree and can be selected by the student as one of the three which must be completed according to the study plan. This course deals with the theoretical foundations of computation. It aims at getting acquaintance with abstract, mathematical models of computation, and the use of such models for assessing the ability to solve computational problems, by identifying both the intrinsic limitations of computing devices, and the practical limitations due to limited availability of resources. To this end the course covers in its core theory of computability including models of computation, computable functions, recursion theory, limits of solvability, as well as computational complexity theory, including complexity measures, complexity classes, problem reduction and completeness. Topical aspects (e.g., emerging models of computation, applications in computational logic, or advanced algorithmic techniques) allow to gain additional knowledge and skills. The main objective is that after completing this course, the students have a deep understanding of the theoretical foundations and the limits of computation. They also have a solid knowledge of complexity theory, which they can apply to establish complexity bounds and characterizations of computational problems in applications, and to develop algorithms for the solution of such problems. A further objective is that the students are able to reason and prove properties about computations in a precise, formal, abstract way.

Module 1	**Theory of Computing**
Teaching language	English
Course code	74017A
Scientific sector	ING-INF/05
Credits	8
Total lecturing hours	48
Total lab hours	--
Total exercise hours	24

Lecturer	Diego Calvanese
Contact	Piazza Domenicani 3, Room 2.07, calvanese@inf.unibz.it, 0471-016160
Scientific sector of the lecturer	ING-INF/05
Office hours	Check the home page of the lecturer
Teaching assistant (if any)	--
Office hours	--
Syllabus	• Formal languages • Formal grammars • Turing Machines • Recursive functions • Undecidability • Computational complexity • NP-completeness • Time and space complexity classes
Teaching format	Frontal lectures.

Module 2	**Research Project in Principles of Computation**
Teaching language	English
Course code	74017B
Scientific sector	ING-INF/05
Credits	4
Total lecturing hours	--
Total lab hours	--
Total exercise hours	--
Lecturer	--
Contact	Supervisor of the project
Scientific sector of the lecturer	--
Office hours	--
Teaching assistant (if any)	--
Office hours	--
Syllabus	The student will further investigate a specific topic covered by the first module. The selection of the topic and the research activity shall be carried out under the supervision of a tutor selected in agreement with the lecturer of the first module.
Teaching format	Supervised project activities.

Learning outcomes	*Knowledge and understanding* • Knowledge of the theoretical foundations of computability and computational complexity • Broad knowledge of foundational and applicative areas of computer science • Thoroughly understand the scientific method of investigation • Understand and being able to use mathematical tools, both concerning discrete and continuous domains, to support computer science studies and development *Applying knowledge and understanding* • Ability to adapt an existing technical solution or formal model according to new requirements or context • Ability to provide an algorithmic solution for a computational problem and to define its computational complexity • Ability to provide an algorithmic solution for a computational problem and to define its computational complexity

	Making judgments • Ability to establish achievable objectives considering time and resource constraints *Communication skills* • -- *Learning skills* • Ability to autonomously broaden acquired knowledge by means of technical and scientific documentation • Ability to extend possibly incomplete knowledge within problem solving activities directed to achieve specific goals

Assessment	The assessment of the course consists of different parts: • midterm or final exam on the first half of the syllabus (35%); • final exam on the second half of the syllabus (35%); • evaluation of the project activities (30%). Each part of the examination may be either written or oral.
Assessment language	English
Evaluation criteria and criteria for awarding marks	At the exam, the student has to solve exercises and answer questions on the course topics in written or oral form. The solution of the exercises requires the ability to apply the notions and techniques studied in the course to novel contexts. The two parts of the examination can be taken independently of each other within the three exam sessions of an academic year. In case of a positive mark for one of the two parts (obtained at the midterm or at one of the first two regular exam sessions), that part will count for all 3 regular exam sessions.

Required readings	• Introduction to Automata Theory, Languages, and Computation (3rd edition). J.E. Hopcroft, R. Motwani, J.D. Ullman. Addison Wesley, 2007. Unibz Library location: ST 130 H791(3.07) • Languages and Machines (3rd edition). Thomas A. Sudkamp. Addison Wesley, 2005. Only Chapter 13 (available on the course webpage).
Supplementary readings	• Elements of the Theory of Computation (2nd edition). H.R Lewis, C.H. Papadimitriou. Prentice Hall. 1998. • Introduction to the Theory of Computation. M. Sipser. PWS Publishing Company. 1997. • Complexity Theory. Ingo Wegener. Springer, 2005. • Computational Complexity. C.H. Papadimitriou. Addison Wesley. 1995.