Program	Level	Second cycle
	Name of the program	Theoretical Computer Science, Applied Mathematics

COURSE

Course title	**Formal Methods and Computability**			
Course code	Semester	Course status	ECTS	Contact hours (L+AE+LE)
CS 430	III	Elective course	7	3+2+0
Lecturer				
Course Goals	Acquainting students with formal models of modern computing, elements of their mathematics and their use in specification and verification. In addition, introduce the student to basic classes of complexity. Algorithms will be described in more detail with a series of examples of certain classes of complexity. Some open ones will be highlighted in particular problems in complexity theory.			
Learning Outcomes	Understanding different types of complexity problems, as well as different types of algorithms. Determining the complexity of the problem, and construction of appropriate algorithms for its solution. Detection of problem severity, and comparison			

COURSE CONTENT

- Definition of a Turing machine; computing with a Turing machine; A multilane Turing machine; Non-deterministic Turing machine;
- Partially recursive functions. Primitively recursive functions, Ackerman function, definition of the class of partially recursive function, proof that every partially recursive function is Turing calculable; highlighted examples of recursive functions and simple properties; recursive sets and relation.
- Church-Turing principle; The stopping problem; Intractable problems;
- Problems from class P; Examples of problems from class P; Class problems NP; Polynomial problem reduction; Examples of reduction; NP-C (NP-complete) problems;
- Examples of NP-complete problems. 2CNF, 3CNF, SAT, HORNSAT, k- colourability, CLIQUE, Hamiltonian paths in a graph, knapsack problem, travelling salesman problem, integer linear problem programming.
- Complexity. Problems and algorithms; time and space, indeterminism, complexity classes - Basic connections. LOGSPACE, P, NP, PSPACE, EXPTIME and NEXPTIME; Cook, Levine's theorem.
- Savitch theorem. PSPACE=NPSPACE; PSPACE-completeness, QBF problem, Stockmeyer's theorem.
- Probabilistic algorithms. non-deterministic Turing machine; class BPP; example problems.
- Cryptography. Private and public keys; one-way functions.

LITERATURE

[1] Hary Lewis, Christos Papadimitriou: Elements of the Theory of Computation, Prentice-Hall, 1997
[2] M. Sipser, Introduction to the Theory of Computation, PWS Publishing Company, 2005.
Additional:
[1] Michael Garey, David Johnson: Computers and Intractability, A Guide to the Theory of NP-Completeness
[2] J. R. Shoenfiled, Recursion Theory, Springer Verlag, 1993.
[3]H. D. Ebbinghaus, J. Flumm, Finite model theory, Springer Verlag, 1999.
[4] C. H. Papadimitriou, Computational Complexity, Addison-Wesley, 1994

STUDENT WORKLOAD (hours in a semester)

Lectures	45	Exercises	30	Individual work	100	T o t a l	175

GRADING			**REMARKS**
Criterion	Maximum points	Minimum points	
Midterm exams	30		
Student projects	40		
Final exam	30		

Total	100	55	