Salem STATE UNIVERSITY

Computer Science Department
cs.salemstate.edu

CSC 710 Theory of Computation

Catalog Description:

This course is dedicated to the analysis of important theoretical issues concerning programs, computers, problems and computation. The course introduces the basic concepts underlying the theoretical study of computing and computers: formal languages, automata, Turing machines, computability, and computational complexity. Three lecture hours per week.

Course Prerequisites: graduate status or permission of graduate program coordinator.

Course Goals:

The aims of this course are:

- CG01: introduce students to the mathematical foundations of computation including automata theory, the theory of formal languages and grammars;
- CG02: introduce the notions of algorithm, decidability, complexity, and computability;
- CG03: enhance and develop the students' ability to understand and conduct mathematical proofs for computation and algorithms.

Course Objectives:

Upon completion of the course, the student will have demonstrated the ability to:

- CO01: define and describe formal models of computation, such as finite automata, pushdown automata, and Turing machines;
- CO02: give examples of languages and computational problems appropriate for different models of computation;
- CO03: create proofs for statements regarding formal models of computation;
- CO04: describe class-based resource usage models, including time and space complexity;
- CO05: apply NP-completeness concepts to create proofs regarding the computational complexity of problems;
- CO06: use basic concepts and explain implications of modern complexity theoretic approaches to advanced topics such as randomization, proof complexity, and quantum computing.

Topics Agenda:

The course topics will be covered in the class in one semester (fifteen weeks) as follows:

- Week01: Automata Theory: deterministic/ nondeterministic finite automata, regular expressions, push-down automata.
- Week02: Language Theory: regular expressions, context free grammars, pumping lemmas.
- Week03: Turing machines and Church-Turing Thesis.
- Week04: Decidability, halting problem.
- Week05: Reducibility, recursion theorem.
- Week06: Time and space measures, hierarchy theorems.
- Week07: Probabilistic analysis, reviews, midterm exam
- Week08: Complexity classes P, NP, L, NL, PSPACE, BPP and IP.
- Week09: Complexity classes P, NP, L, NL, PSPACE, BPP and IP (cont'd).
- Week10: Notion of completeness within a complexity class, P versus NP conjecture, provably hard problems.
- Week11: Probabilistic computation.
- Week12: Relativized computation and oracles.
- Week13: Interactive proof systems.
- Week14: Possible advanced topic as time permits.
- Week15: Student presentations, reviews, final exam.

Testing and Grading:

Homework assignments will be given every two to three weeks, including reports on assigned reading in books and journals. Oral presentations on selected topics will also be required. Quizzes may be used during the semester. There will be one mid-term exam and one comprehensive final examination.

The final grade will be determined using the following approximate weights:

written assignments 40%
mid-term 20%
quizzes and/or oral presentations 10%.
final examination 30%

Bibliography:

Hopcroft, John E.; Motwani, Rajeev; Ullman, Jeffrey D. **Introduction to Automata Theory, Languages, and Computation**. 3rd ed. Addison Wesley, 2006. ISBN 0321455363

Kozen, Dexter. **Theory of Computation**. 1st ed. Springer, 2010. ISBN: 1849965714

Lewis, Harry R.; Papadimitriou, Christos H. **Elements of the Theory of Computation**. 2nd ed. Prentice Hall, 1997. ISBN: 0132624788

Linz, Peter. **An Introduction to Formal Languages and Automata**. 5th ed. Jones and Bartlett, 2006. ISBN 144961552X

Martin, John C. **Introduction to Languages and the Theory of Computation**. 4th ed. McGraw-Hill, 2010. ISBN: 0073191469

Sipser, Michael. **Introduction to the Theory of Computation**. 3rd ed. Cengage Learning, 2012. ISBN: 113318779X