Course Description

This is a course about formal models for hardware and software, leading to a deeper understanding of computation. The course material also serves as a foundation for compiler design, the design of programming languages, natural language analysis, complexity, and bioinformatics. We shall study automata, formal languages, the type of computation that is captured by each model, the limits of each model and the limits of computation. Three classes of formal language will be studied: regular languages, context-free languages, and recursively enumerable languages, along with their associated hardware models.

Professor	Dr. J.K. Johnstone, CH125
Time	TTh 9:30-10:45am, CH145
TA	Zekai Demirezen (zekzek@cis.uab.edu)
Office Hours	Johnstone: MW2-3, CH125; Demirezen: Th8-10am, F6-8pm, CH154; or by appointment
Prerequisites	CS250, CS302, and MA125 (with grades of C or better in all)
Textbook	J.E. Hopcroft, R. Motwani, and J.D. Ullman (2001) *Introduction to Automata Theory, Languages, and Computation*, Addison-Wesley.
Website	www.cis.uab.edu/cs350/

Additional References

- *Automata and Computability* by Dexter Kozen (Springer, 1997).
- *Elements of the Theory of Computation* by Harry Lewis and Christos Papadimitriou (Prentice-Hall, 1981).
- *Introduction to the Theory of Computation* by Michael Sipser (PWS Publishing, 1997).
- *Computers and Intractability: A Guide to the Theory of NP-Completeness* by Garey and Johnson (W.H. Freeman, 1979).

Grading

Homework (6)	30%
Midterm 1 (Thursday, September 20, closed book)	20%
Midterm 2 (Thursday, October 25, closed book)	20%
Final (Tuesday, Dec. 11, 8-10:30am, closed book)	30%

Homework	Chapters covered	Due date	Topic
HW1	1-2	Sept. 6	DFA, NFA
HW2	2-3	Sept. 13	NFA, DFA, RE translations
HW3	3-4	October 4	RE, pumping lemma 1, closure
HW4	5-6	October 18	CFG, parsing, PDA
HW5	6-7	November 8	CNF, GNF, pumping lemma 2
HW6	8-10	November 29	TM, NPC

There will be differences between the 350 and 550 versions of the homework and exams. I will drop your lowest mark on these 6 homeworks. Every homework is weighted equally. Homework is due in class, at the beginning of class. Late penalty is 10% per day; however, note that the homework must be handed in before a homework solution is handed back, which will be done within a week. (Homework is due on Thursday and hopefully returned by the next Tuesday.) Late homework should be handed in to the department office (Campbell 115), with a secretary's signature acknowledging time and date of receipt. Homeworks will be marked by the TA. I will mark all exams and create all solution sets for the homework (which are followed in marking the homework). Last day to withdraw with 'W': October 22, 2007.

Curriculum

1. Proof techniques (Chapter 1)
2. Regular languages (Chapters 2-4)
   (a) Deterministic and nondeterministic finite automata.
   (b) Regular expressions.
   (c) Regular grammars.
   (d) Properties of regular languages (pumping lemma, closure and decision properties)
3. Context-free languages (Chapters 5-7)
   (a) Context-free grammars.
   (b) Parsing and ambiguity.
   (c) Simplification and normal forms for context-free grammars.
   (d) Pushdown automata.
   (e) Properties of context-free languages (pumping lemma, closure and decision properties)
4. Recursively enumerable languages (Chapter 8)
   (a) Turing machines.

(b) Church's thesis.

5. Computability and decidability (Chapters 9-10)

   (a) Undecidable problems.

   (b) Chomsky hierarchy.

   (c) Intractable problems.

   (d) P vs. NP; NP-completeness.

Goals

This course has three goals. I want you to learn how to strip hardware and software down to its essentials, in the form of an automaton or grammar. This allows abstract or formal reasoning about the hardware or software, which is required in compiler design, programming language design, and proofs of correctness for hardware. I also want you to learn the limits of computation (for example, when is a heuristic method appropriate?) and the ability to categorize levels of computational complexity (for example, why are regular expressions sufficient for most of what Perl does, and in turn for most of bioinformatics?). Finally, I want you to learn to think precisely and formally, including a refinement of your ability to prove things.

Grading policy

In general, the marking scheme for this class will be as follows.

- A = 90-100
- B = 80-89
- C = 70-79
- D = 55-69

These standards may be adjusted for certain exams or homeworks. These adjustments will be announced in class as the exam/homework is handed back.

Attendance policy

You are expected to attend every class. If you must miss a class because of illness or other unavoidable reason, you are responsible for getting the notes and any assignments from a fellow student. Large gaps in attendance are not acceptable (e.g., if you must work during class hours, please drop the course). If you miss more than 10 classes, you will receive a 10% penalty on your final grade.

Honour code

All of the following are strictly forbidden:

- Any form of cooperation on exams, whether take-home or in-class.
- Any form of cooperation on homework, other than preliminary oral discussion at a high level (that is, definition of the problem). Homework is to be solved and written up alone and independently.
- Any coercion of other students to help on homework or exams (even if help is not forthcoming).

All references and/or websites used must be included in a bibliography. Care must be taken not to plagiarize.

Violations of any part of this honour code will result in a 0 on that exam/homework, possible failure of the course, and possible forwarding of the case to the school ethics board, where a decision about expulsion from UAB is made.

Makeup policy

Midterm exams can be made up if missed due to illness, upon receipt of a doctor's note. The final exam cannot be made up. The final exam cannot be offered to students early (e.g., for Christmas travel).