CS 341: Foundations of Computer Science II
Spring 2010, Face-to-Face Section

Course Info

Class Times: Monday 4:00 – 5:25, Wednesday 1:00 – 2:25
Instructor: Prof. Marvin K. Nakayama
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Course Webpage: `http://web.njit.edu/~marvin/cs341`

Description

This course presents some of the most fundamental results in theoretical Computer Science. These results attempt to answer, in a precise mathematical sense, the following two questions, which are of practical as well as philosophical interest:

1. Can a given problem be solved by computation?
2. How efficiently can a given problem be solved by computation?

We focus on *problems* rather than on specific *algorithms* for solving problems. To answer both questions mathematically, we will need to formalize the notion of "computer" or "machine." The course outline breaks naturally into three parts:

1. Models of computation (Automata Theory)
   - Finite automata
   - Push-down automata
   - Turing machines
2. What can we compute? (Computability Theory)
3. How efficiently can we compute? (Complexity Theory)

Specifically, the topics covered will include regular languages (finite automata, regular expressions), nonregular languages, context-free languages (context-free grammars, pushdown automata), non-context-free languages, Turing machines and variants, Church-Turing Thesis, undecidability, reducibility, time complexity, and complexity classes P, NP, and NP-complete.

Learning Objectives

After completing the course, students will be able to:

- Classify a particular language as regular, context-free, decidable or undecidable.

- Provide a finite automaton and regular expression for a regular language.
- Prove that a nonregular language is not regular.
- Provide a context-free grammar and pushdown automaton for a context-free language.
- Prove that a non-context-free language is not context-free.
- Provide a description of a Turing machine for a decidable language.
- Prove closure properties of classes of languages.
- Prove that certain languages (e.g., the halting problem) are undecidable.
- Understand the significance of complexity classes P, NP and NP-complete, and carry out some NP-completeness reductions.

Textbook

Michael Sipser, *Introduction to the Theory of Computation, Second Edition.* Course Technology, 2005. ISBN: 0-534-95097-3. We will cover Chapters 0–5, and 7, following the schedule given at the end of this handout. The first edition of the Sipser book is also acceptable for this class, although the page numbers and sections of the book referenced in the notes and assignments may differ.

Prerequisites

You must complete all of the following *before* taking CS 341:

1. A 100-series general undergraduate required course in CS
2. Math 226 (Discrete Mathematics) or CS 241 (Foundations of Computer Science I)
3. CS 280 (Programming Language Concepts).

Grading

Your course grade will be determined by two programming assignments, one in-class quiz, two in-class midterms and a final exam. All quizzes and exams will be closed book and closed notes. Each quiz will be about 25 minutes long, the midterm exams will be 85 minutes long, and the final exam will be 2.5 hours long. Unless notified otherwise, the dates of the quizzes and midterms and the due date for the programming assignment will be as given in the schedule at the end of this document.

Your final grade will be based on the following weights:

Programming Assignments	25%
Quiz	10%
Midterms	35%
Final Exam	30%

For each programming assignment, students who do not turn in a minimally working program will get a 0 for the assignment *and* have their course grades at the end of the semester lowered by one step, e.g., from B to C+, or from C to D. Hence, if you do not turn in a minimally working program for neither assignment, your course grade will be lowered by two steps, e.g., from B to C or from C to F.

Course grades will be assigned on a curve using the following approach. First, I will rank everyone using the cumulative scores with the weights given above, and then assign *preliminary grades* based on that. The top group of students will get a preliminary grade of A, the next group will receive a preliminary grade of B, etc. Any student who scores less than 20 out of 100 on the final will automatically receive an F for the course.

After assigning preliminary grades, I will make adjustments for those who did not turn in minimally working programs. For each programming assignment for which you did not turn in a minimally working program, your preliminary grade will be lowered by one step. For example, if your preliminary grade was B and you only turned in one minimally working program out of the two programming assignments, then your course grade is C+; if you did not turn in a minimally working program for neither assignment, then your course grade drops to a C. If you turned in minimally working programs for both assignments, then your course grade is your preliminary grade based on the ranking of cumulative scores.

Course Materials

All of the course handouts (including lecture notes and assignments) are available in PDF format through my CS 341 homepage, whose address is given on the first page. **You must bring printouts of the lecture notes to each class.** To read the files, you will need to use a software package called Adobe Reader, which you can download for free using a link from the course web page. You must have version 4.0 or later of Adobe Reader. Be sure to check the course homepage each day since I will post announcements on it.

Course Policies

Punctuality and class attendance is mandatory. **If you cannot attend some class, you must contact me beforehand. As a general rule, I do not give makeup exams or quizzes, I do not allow allow students to take exams or quizzes on alternate dates, nor do I allow students to turn in assignments late.** Of course, if someone has a legitimate reason (e.g., jury duty, serious medical problem, conflict with a religious holiday), I will make allowances as long as you provide proper documentation (e.g., a doctor's note that I can keep). I will not accept excuses such as having too heavy a workload, having too many exams the same week, or simply forgetting. **Also, I do not give out extra-credit assignments.**

If upon getting back one of your exams or quizzes you think that you deserve more points on a particular problem, I will regrade the entire exam or quiz. Thus, you may get more points on the one problem, but you may lose points on other problems. Also, any questions about the grading must be asked within 48 hours of when the exam or quiz was handed back in class.

For all exams and quizzes, be sure to bring a photo ID. All exams and quizzes will be closed book and closed notes.

All portable electronic devices, such as cellphones and laptops, must be turned off during class.

Students will be informed of any modifications or deviations from the syllabus throughout the course of the semester.

Homework Assignments

You do not need turn in the homework assignments. However, the only way you will learn the material is by doing the assignments, and many problems on the exams and quizzes will be based on the homework problems. When doing the homework problems, you should show all work and give reasons (e.g., proofs) for your answers because this is what you be required to do for the quizzes and exams. If your proof relies on a theorem or result from the book, be sure to either state the theorem number or page number from the book.

Programming Assignments

The programming assignments are mandatory, and you must turn it in at the beginning of class the day it is due. **Late programs will not be accepted.**

After the first two weeks of lectures, we will have covered enough material for you to do the first program. Expect to spend at least 5–10 hours on each programming assignment, so do not wait until the last minute to try to complete it.

Schedule

Unless I announce otherwise, the schedule for the semester is as below. Although you do not need to turn in the homework, you should complete the assignments according to the schedule below.

Week	Topic	Reading	Homework	Other
1	Intro, Languages	Chapter 0	HW 1	
2	Regular Languages: DFA, NFA	Chapter 1	HW 2	
3	RL: Closure Properties, Reg Exp	Chapter 1	HW 3	Quiz 1 (2/3)
4	Kleene's Thm, Nonregular Lang	Chapter 1	HW 4	
5	CFG, PDA	Chapter 2	HW 5	Prog 1 due (2/17)
6	CFG = PDA, Non-CFL	Chapter 2	HW 6	
7	Turing Machines	Chapter 3	HW 7	Midterm 1 (3/3)
8	Algorithms, Decidability	Chapter 4	HW 8	Prog 2 due (3/10)
9	Decidability, Halting Problem	Chapter 4	HW 9	
10	Undecidable Problems	Chapter 5	HW 10	
11	Undecidability Reductions	Chapter 5	HW 11	Midterm 2 (4/7)
12	Time Complexity, Class P	Chapter 7	HW 12	
13	Classes NP, NP-Complete	Chapter 7	HW 13	
14	NP-Complete Reductions	Chapter 7		

Honor Code

Students must obey the academic honor code. Any student caught cheating will be reported immediately to the Dean of Students. Cheating includes, but is not limited to,

- communicating with others during exams
- using unauthorized materials during exams
- copying/giving a computer program from/to another person.

For any quizzes or exams that are less than 90 minutes in length, students will not be allowed to leave the classroom once the exam or quiz has begun.