# CS 341: Foundations of Computer Science II
# eLearning Section Syllabus, Fall 2009

## Course 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." Thus, 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 finite automata and regular languages, context-free languages, pushdown automata, Turing machines, Church-Turing Thesis, undecidability, reducibility, time complexity, and complexity classes P, NP, and NP-complete.

## Instructor Information

- Prof. Marvin K. Nakayama
- Postal Address:
  Guttenberg Information Technologies Center, Room 4312
  Computer Science Department
  New Jersey Institute of Technology
  Newark, NJ 07102
- Phone: (973) 596-3398
- e-mail: `marvin@njit.edu` . Be sure to put CS341EL in the subject line. Only send e-mails about personal concerns (e.g., your performance in the class). Post any general questions on moodle (described below).
- Office hours: Monday, Thursday, 1:30 – 3:00, in my office. Also, you can see me by appointment or send me e-mail (be sure to put "CS341EL" in the subject line).

## Course Webpage

`http://web.njit.edu/~marvin/cs341`

All of the lecture notes, homework assignments and solutions, and programming assignments are available in PDF format on the CS 341 webpage. Be sure to check the course homepage everyday since I will post announcements on it.

## 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 have completed all of the following prerequisites before enrolling in 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).

## Exams

There will be one midterm, which will be given on a Saturday around the end of the 7th week of the semester, tentatively Saturday, October 17. The final exam will be on Saturday, December 12. More details of the exact dates, times and locations of the exams will be given during the semester.

If you live within a 100-mile radius of the NJIT Newark campus, you must take the midterm and final exam there on the date and time announced for each. If you live outside of the 100-mile radius of the NJIT Newark campus, then you need to nominate a proctor in Homework Assignment EL.

You must bring 2 forms of photo ID to all exams.

## Course Policies

As a general rule, I do not give makeup exams nor allow students to take exams on alternate dates. Also, I do not accept late assignments. 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 contact me beforehand and you provide proper documentation (e.g., a note from your doctor). I will not accept excuses such as having too heavy a workload, having too many exams the same week, or forgetting.

If upon getting back one of your exams you think that you deserve more points on a particular problem, I will regrade the entire exam. Thus, you may get more points on the one problem, but

you may lose points on other problems. You must ask for a regrade within one week of when I return them.

There are no extra-credit assignments available. So you need to make sure that you perform well on the assignments and exams.

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

## Honor Code

Students must obey the academic honor code, and 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 a program from or giving a program to another person.

## Course Grade

Your final grade will be based on the following breakdown:

| | |
|---|---|
| Homework Assignment EL | 10% |
| Programming Assignments | 30% |
| Midterm | 30% |
| 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. Thus, if you do not turn in minimally working programs for either assignment, then your course grade will drop 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 minimally working programs for either 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.

## Lectures

As a student in an eLearning course, you will not be attending traditional "face to face" lectures but instead will watch on your computer a collection of "modules" that I recorded. The modules are videos of the lecture notes with voiceovers, and they cover the same material that I teach in a face-to-face version of CS 341. All the modules are available as free video podcasts from the NJIT iTunes webpage:

`http://itunes.njit.edu`

You will need iTunes, which you can download from a link on the above webpage, installed on your computer to view the videos. Once you have iTunes installed, to access the lecture videos, you must start up iTunes through the NJIT iTunes page. After logging into iTunes through the NJIT iTunes webpage, go to Store → iTunes Store, and you should see a link in iTunes for CS 341 in the Course Lectures section. The preface of the lecture notes describes how the recorded modules correspond to the pages in the lecture notes.

## Homework Assignments

You must download the homework assignments from the course webpage. Do not turn in any of the homework assignments (except for assignment EL, which is required and will count towards 10% of your final grade).

For each problem, be sure to show all work and give reasons (e.g., proofs) for your answers. 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

All students must complete the two programming assignments, which you can download from the course webpage. The due date is given in the schedule at the end of the syllabus. Each programming assignment will take some time to complete (about 5–10 hours), so you should not wait until the last minute to do it. The lectures in the second week cover the material on which the first programming assignment is based, so you can get started on it then.

For each programming assignment, any student who does not turn in a minimally working program will have his/her course grade lowered by one step, e.g., B to C+. Hence, if for both assignments you do not turn in minimally working programs, your course grade will be lowered by two steps, e.g., from B to C or from C to F.

## moodle

For this eLearning class, we will be using a computer-based group-communication system called moodle, which you can access at

`http://moodle.njit.edu/`

The website also provides instructions on using moodle. You must visit the moodle several times a week as I will post important announcements there on the News forum. Also, I encourage you to post general questions about the course or material there; if you don't understand some concept or find something confusing, it's likely that other students have the same problem, so having questions posted and answered in an open forum will benefit everyone in the class. I will respond to all questions posted on moodle.

### Semester Schedule

Week 1. Mathematical background.
Complete the following by September 7:

- Read Chapter 0 of the textbook.
- Watch Modules 0a, 0b, . . . , 0f.
- Complete Homework 1.

Week 2. Regular languages, DFAs and NFAs.
Complete the following by September 14:

- Read Section 1.1 of the textbook.
- Watch Modules 0g, 1a, 1b, 1c.
- Complete Homework 2 and **Homework EL**.

Week 3. Closure properties of regular languages, regular expressions.
Complete the following by September 21:

- Read Sections 1.2 and 1.3 of the textbook.
- Watch Modules 1d, 1e, 1f, 1g.
- Complete Homework 3.

Week 4. Kleene's theorem, Nonregular languages.
Complete the following by September 28:

- Read Section 1.4 of the textbook.
- Watch Modules 1h, 1i, 1j, 1k, 2a.
- Complete Homework 4.
- **Turn in Programming Assignment 1.**

Week 5. Context-free grammars, pushdown automata.
Complete the following by October 5:

- Read Section 2.1 and start on Section 2.2 of the textbook.
- Watch Modules 2b, 2c, . . . , 2g.
- Complete Homework 5.

Week 6. Pushdown automata, non-context-free languages.
Complete the following by October 12:

- Read the rest of Section 2.2 and Section 2.3 of the textbook.
- Watch Modules 2h, 2i, 2j, 2k, 2l.
- Complete Homework 6.

Week 7. Turing machines, variants of Turing machines.
Complete the following by October 19:

- Read Sections 3.1 and 3.2 of the textbook.
- Watch Modules 3a, 3b, . . . , 3e.
- Complete Homework 7.

**Midterm:** tentatively Saturday, October 17.

Week 8. Church-Turing thesis, encoding of Turing machines, Turing-decidable languages.
Complete the following by October 26:

- Read Sections 3.3 and 4.1 of the textbook.
- Watch Modules 3f, 3g, 3h, 3i, 4a, 4b.
- **Turn in Programming Assignment 2.**

Week 9. Turing-decidable languages, the halting problem.
Complete the following by November 2:

- Read Section 4.2 of the textbook.
- Watch Modules 4c, 4d, . . . , 4h.
- Complete Homework 8.

Week 10. Undecidable languages, mapping reducibility.
Complete the following by November 9:

- Read Sections 5.1 and 5.2 and start reading Section 5.3 of the textbook.
- Watch Modules 5a, 5b, 5c, 5d.
- Complete Homework 9.

Week 11. Unrecognizable languages, time complexity.
Complete the following by November 16:

- Read Sections 5.3 and 7.1 of the textbook.
- Watch Modules 5e, 7a, 7b, 7c, 7d.
- Complete Homework 10.

Week 12. Class P.
Complete the following by November 23:

- Read Section 7.2 of the textbook.
- Watch Modules 7e, 7f, 7g, 7h, 7i, 7j.
- Complete Homework 11.

Week 13. Class NP, polynomial-time mapping reducibility.
Complete the following by November 30:

- Read Section 7.3 and start reading Section 7.4 of the textbook.
- Watch Modules 7k, 7l, 7m, 7n, 7o.
- Complete Homework 12.

Week 14. NP-completeness.
Complete the following by December 7:

- Read Sections 7.4 and 7.5 of the textbook.
- Watch Modules 7p, 7q, 7r.
- Complete Homework 13.

**Final Exam:** Saturday, December 12.