Fall 2020

CS 341-001: Foundations of Computer Science II

Marvin Nakayama

CS 341-001: Foundations of Computer Science II
Syllabus, Fall 2020, Synchronous-Online Hybrid Section

Course Info

Class Times: Tuesday, 2:30pm – 3:50pm (via Webex)
Instructor: Prof. Marvin K. Nakayama
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Office Hours (via Webex):
Tuesdays, Wednesdays: 10:00am – 12:50pm (Webex),
or by appointment.
Course Webpage: `https://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 often 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.

Course Outcomes

The student course outcomes of CS 341 are to

- Understand the capabilities and limitations of different models of computation.
- Understand what problems can be solved by computation and which cannot.
- Understand what problems can be solved efficiently and those for which there is no known efficient solution.

The specific learning objectives are that after completing the course, students will be able to

- Classify a particular language as regular, context-free, decidable, Turing-recognizable or non-Turing-recognizable.
- 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 or disprove closure properties (under union, intersection, complementation, Kleene star) of classes of languages.
- Prove that certain languages are undecidable or non-Turing-recognizable.
- Understand nondeterminism and its role in computation and complexity theory.
- Understand the significance of complexity classes P and NP, and perform NP-completeness reductions.

Textbook

Michael Sipser, *Introduction to the Theory of Computation, Third Edition.* Course Technology, 2012, ISBN-10: 113318779X, ISBN-13: 978-1133187790. We will cover Chapters 0–5, and 7, following the schedule given at the end of this handout. Earlier editions of the Sipser book are also acceptable for this class, although the page numbers and sections of the book referenced in the notes and assignments may differ, and some terminology has changed.

Prerequisites

Before taking CS 341, you must complete all of the following with grades of C or better:

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

Grading

Your course grade will be determined by one project(s) (programming assignment(s)), two midterms and a final exam. **All exams will be closed book and closed notes, and held during regular class meeting times.** Exams will be given online, likely using Canvas (see below) and an online proctoring service, such as ProctorU. The midterm exams will last the entire class period, and the final exam will be 2.5 hours long. Unless notified otherwise, the dates of the midterms and the due date(s) for the project(s) are as given in the schedule at the end of this document.

Your final grade will be based on the following weights:

Project (1)	10%
Midterms (2)	55%
Final Exam	35%

For each project, 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 minimally working programs for two projects (if there is more than one in the course), your course grade will be lowered by two steps, e.g., from B to C or from C to F.

Students caught violating the NJIT University Policy on Academic Integrity on a project will get a 0 for the project *and* have their course grades lowered by two steps (e.g., B+ to C+, or C to F) for each violation.

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.

After assigning preliminary grades, I will make adjustments for those who did not turn in minimally working programs or violated the NJIT University Policy on Academic Integrity. For each project for which you did not turn in a minimally working program, your preliminary grade will be lowered by one step. For each violation of the NJIT University Policy on Academic Integrity, your preliminary grade will be lowered by two steps. For example, if your preliminary grade was B and you did not turn in a minimally working program for exactly one project, then your course grade is C+; if you did not turn in minimally working programs for exactly two projects (when there is more than one in the course), then your course grade drops to a C. If you turned in minimally working programs for all projects and did not violate the NJIT University Policy on Academic Integrity on any of them, then your course grade is your preliminary grade based on the ranking of cumulative scores.

If there is a large discrepancy between your exam scores and the scores on the project(s), the exams may be more heavily weighted in determining your course grade.

Learning Management System: Canvas

In this course we will use a computer-based group-communication system called Canvas, which you can access at

`https://Canvas.njit.edu/`

The website also provides instructions on using Canvas, which requires logging in with your NJIT UCID. All projects must be submitted through Canvas. Also, the course Canvas page will have a link to video recordings of all of the lecture material. The preface of the lecture notes describes how the recorded modules correspond to the pages in the lecture notes.

Exams

All exams will be online through Canvas and ProctorU Review+, which is AI-based rather than with a live proctor. ProctorU Review+ requires using a chrome (recommended) or Firefox web browser on a Windows or MacOS computer. You must install a ProctorU browser extension, which you should do now and test it out well before the exam.

For all exams, you will be required to present a photo ID. All exams will be closed book and closed notes. For any exams that are less than 90 minutes in length, if a student wants to leaves the room after the exam has begun, s/he must turn in her/his exam before leaving and will not be allowed back in the room.

If a student is caught with an unauthorized material or device during an exam, the student's exam will be taken away and the student will be reported to the dean of students.

Course Policies

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 and homework assignments to each class.** Be sure to check the Canvas each day since I will post announcements on it. (In Canvas, you should set your Notification Preferences so that you receive an email whenever an Announcement is posted.)

As a general rule, I do not give makeup exams, I do not allow allow students to take exams 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 **contact me beforehand** (whenever it is feasible to do so) and provide proper documentation (e.g., a doctor's note) to the Dean of Students, who will let me know if your absence can be excused. I will not accept excuses such as having too heavy a workload, having too many exams the same week, or simply forgetting.

If upon getting back graded material (e.g., exam, project) you think that you deserve more points on a particular part, I may regrade the entire thing. Thus, you may get more points on the one part, but you may lose points on other parts. **You must ask for a regrade within one week of when the graded material is returned to the class or you are informed of your score, whichever is earlier.**

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.

Hybrid Section

Students in a hybrid section will attend weekly face-to-face classes via Webex, in which I will go over homework problems and review material. Outside of class, students will watch on their computers 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 video podcasts through a link posted in the course Canvas webpage. The preface of the lecture notes describes how the recorded modules correspond to the pages in the lecture notes.

Homework Assignments

All homework solutions are posted on the web at the beginning of the semester. *Do not 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 will be based on the homework problems.

When working on the homework problems, 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. Writing out complete solutions will help you prepare for the exams. Thus, it is important to do the homework, even though you do not turn them in.

Projects

Each project (programming assignment) is mandatory, and must be turned by the due date/time. Late projects will be penalized as follows:

Lateness (Hours)	Penalty
$0.0 < \text{Lateness} \leq 24$	10
$24 < \text{Lateness} \leq 48$	30
$48 < \text{Lateness} \leq 72$	60
$72 < \text{Lateness}$	100

For example, because Project 1 is due by 2:30pm NJ local time on 10/6/2020, you must submit **all** required documents for it by that date/time to not be penalized. If you complete your entire submission after the due date/time but up to 24 hours later, then you will automatically lose 10 points of the project. If you complete your entire submission between 24 hours and 48 hours late, then you will automatically lose 30 points of the project. If you complete your entire submission between 48 hours and 72 hours late, then you will automatically lose 60 points of the project. Projects completed over 72 hours late 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 project, so do not wait until the last minute to try to complete it. Each project must be submitted through Canvas.

Students may be called in to explain their projects in person or via Webex. If you are asked to come to explain your project in person, then you must do it; otherwise, you will receive a 0 on the project, and have your course grade lowered by one step.

Academic Integrity

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the University Policy on Academic Integrity that is found at:

`https://www.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf`

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. **Any student found in violation of the policy by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F or XF, and/or suspension or dismissal from the university.** If you have any questions about the University Policy on Academic Integrity, please contact the Dean of Students Office at `dos@njit.edu` .

Semester 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. The reading assignments are from the course textbook.

Week	Topic	Modules	Reading	Homework	Complete By
1	Intro, Languages	0, 0a to 0f	Chapter 0	HW 1	9/15
2	Regular Languages, DFA	0g to 1c	Chapter 1	HW 2	9/22
3	NFA, Reg Exp, Kleene's Thm	1d to 1i	Chapter 1	HW 3	9/29
4	Nonregular Lang, CFL	1j to 2a	Chapter 1, 2	HW 4	10/6
5	CFG, PDA	2b to 2g	Chapter 2	HW 5	10/13
6	Non-CFL, Turing Machines	2h to 3c	Chapter 2, 3	HW 6	10/20
7	Church-Turing Thesis	3d to 3i	Chapter 3	HW 7	10/27
8	Decidability	4a to 4e	Chapter 4	HW 8	11/3
9	Halting Problem, Reductions	4f to 5c	Chapter 4, 5	HW 9	11/10
10	Undecidable Problems, Big-O	5d to 5f, 7a, 7b	Chapter 5, 7	HW 10	11/17
11	Time Complexity, Class P	7c to 7h	Chapter 7	HW 11	11/24
12	Classes P and NP	7i to 7m	Chapter 7	HW 12	12/1
13	Class NP-Complete	7n to 7r	Chapter 7	HW 13	12/8
14	Review	Review1 to 6			12/14

Important Dates

The dates/times of exams and assignment(s) are as below, subject to change.

- Verification of Presence: complete on Canvas by 9/8/2020, 11:55pm NJ local time.
- Project 1 due: 10/6/2020, 2:30pm NJ local time.
- Midterm 1: 10/20/2020, online during regular class time.

- Midterm 2: 11/17/2020, online during regular class time.
- Final exam: online during finals week, date/time determined by the registrar.