CS 341-007: Foundations of Computer Science II
Syllabus, Fall 2023, Hybrid Section

Course Info

Class Times: Monday, 11:30am – 12:50pm (in person)
Instructor: Prof. Marvin K. Nakayama
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Office Hours:
Monday, Thursday: 10:00am – 11:15am (Office and Webex)
or by appointment.
Course Webpage: https://web.njit.edu/~marvin/cs341
Tutoring: https://computing.njit.edu/tutoring

Catalog Course Description

This course provides an introduction to automata theory, computability theory, and complexity theory. Theoretical models such as finite-state machines, push-down stack machines, and Turing machines are developed and related to issues in programming language theory. Also, the course covers undecidability and complexity classes P, NP, and NPC.

Detailed 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 course outcomes of CS 341 are to

- Explain and prove the capabilities and limitations of different models of computation.
- Categorize and prove what problems can be solved by computation and which cannot.
- Categorize and prove 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 and prove a particular language as regular, context-free, decidable, Turing-recognizable or non-Turing-recognizable.
- Design a finite automaton and regular expression for a regular language.
- Prove that a nonregular language is not regular.
- Design a context-free grammar and pushdown automaton for a context-free language.
- Prove that a non-context-free language is not context-free.
- Design a Turing machine for a decidable language.
- Prove or disprove closure properties (under union, intersection, concatenation, complementation, Kleene star) of classes of languages.
- Prove that certain languages are undecidable or non-Turing-recognizable.
- Explain nondeterminism and its role in computation and complexity theory.
- Explain the significance of complexity classes P, NP, and NP-complete, and perform reductions to prove NP-completeness of certain languages.

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).

Course Materials and Learning Management System: Canvas

Most of the course materials are posted on the course webpage (URL specified on the first page). In addition, this course will also 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.

Hybrid Section

Students in a hybrid section will attend weekly face-to-face classes, in which I will go over homework problems and cover the key ideas of the course. Outside of class, students will watch on their devices 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 through a link posted in the course Canvas webpage.

Grading

The graded assessments in the course are two project(s) (programming assignment(s)), one midterm and a final exam. Your course grade will be based on the following weights:

Projects (2)	40%
Midterm (1)	25%
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 will 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.

Exams

All exams will be closed book and closed notes. Each midterm is held during regular class meeting times. The final exam will be given during the time slot assigned by the NJIT Registrar. The midterm exam(s) will last the entire class period, and the final exam will be 2.5 hours long. Unless notified otherwise, the date(s) of the midterm(s) and the due date(s) for the project(s) are as given in the schedule at the end of this document.

For all exams, you will be required to present a photo ID. For any exams that are less than 90 minutes in length, if a student wants to leaves the room after the exam has begun, they must turn in their exam before leaving and will not be allowed back in the room. Also, calculators will not be allowed nor will they be needed.

If a student violates the University Policy on Academic Integrity (e.g., using unauthorized material or device) during an exam, the student will be reported to the dean of students.

Mode of Instructional Delivery

The current plan is for classes and exams to be Hybrid in person (face-to-face). But there is a chance (e.g., if the university moves to online-only classes because of the pandemic) that classes may instead meet online using Webex or that exams may be instead be given online. If exams are given online, they will be through Canvas and ProctorU Record+; see below for more information. In any case, students need to sign up for ProctorU Record+ now.

Online Proctoring of Exams (If Needed)

NJIT policy requires that all midterm and final exams must be proctored, regardless of delivery mode, in order to increase academic integrity. Note that this does not apply to essay or authentic based assessments. Effective beginning Fall semester 2019, students registered for a fully online

course section (e.g., online or Hyflex mode) must be given the option to take their exam in a completely online format, with appropriate proctoring.

In this course you will be required to use the following proctoring method to ensure academic integrity for exams. See below for more information about how exams will be proctored in this course.

ProctorU Record+ (If Needed)

ProctorU Record+ uses an automated proctoring solution via AI during the exam, followed by a full review from a ProctorU proctor. Similar to Respondus Monitor, you will be recorded during the exam. After completing their review, a proctor sends an incident report to the instructor if any potential academic integrity violations occur.

Before taking the exam, you must create a test-taker account at ProctorU, and install the Guardian browser from Meazure Learning (ProctorU's parent company). Instructions for setting up ProctorU Record+ are available from here and here. To use this ProctorU service, you will need the following:

- High-speed internet connection
- Webcam (internal or external)
- Microphone and Audio (internal or external)
- Computer running Windows or Mac Operating System
- NJIT ID or Government-Issued Photo ID

If you encounter technical difficulties with your exam, you should contact ProctorU's 24/7 technical support via Live Chat or call 855-772-8678.

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 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.

Homework Assignments

All homework solutions are posted on the course webpage at the beginning of the semester. *Do not turn in the homework assignments.* However, the best way to 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 to not be penalized for lateness. Late projects will be penalized as follows:

Lateness (Hours)	Penalty
$0.00 < \text{Lateness} \leq 24$	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 11:30am NJ local time on 10/9/2023, 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 academic code of integrity policy 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 code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.** If you have any questions about the code of 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	9/18
2	Regular Languages, DFA	0g to 1c	Chapter 1	HW 2	9/25
3	NFA, Reg Exp, Kleene's Thm	1d to 1i	Chapter 1	HW 3	10/2
4	Nonregular Lang, CFL	1j to 2a	Chapter 1, 2	HW 4	10/9
5	CFG, PDA	2b to 2g	Chapter 2	HW 5	10/16
6	Non-CFL, Turing Machines	2h to 3c	Chapter 2, 3	HW 6	10/23
7	Church-Turing Thesis	3d to 3i	Chapter 3	HW 7	10/30
8	Decidability	4a to 4e	Chapter 4	HW 8	11/6
9	Halting Problem, Reductions	4f to 5c	Chapter 4, 5	HW 9	11/13
10	Undecidable Problems, Big-O	5d to 5f, 7a, 7b	Chapter 5, 7	HW 10	11/20
11	Time Complexity, Class P	7c to 7h	Chapter 7	HW 11	11/27
12	Classes P and NP	7i to 7m	Chapter 7	HW 12	12/4
13	Class NP-Complete	7n to 7r	Chapter 7	HW 13	12/11
14	Review	Review1 to 6			12/15

Important Dates

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

- Verification of Presence: complete on Canvas by 9/14/2023, 11:55pm NJ local time.
- Project 1 due: 10/9/2023, 11:30am NJ local time.
- Midterm 1: 10/23/2023, in person during regular class time.
- Project 2 due: 11/6/2023, 11:30am NJ local time.
- Final exam: during finals week, date/time determined by the registrar.