

## CS 340 • Formal Languages and Automata Theory

Fall 2016

CRN 44643 • 3 credits

TR 9:25am-10:40am • D318

Dr. Carolyn Pe Rosiene

rosiene@hartford.edu

University of Hartford

Office Hours: Dana 335 • T 8:30-9, 10:50-12, 2-3. R 10:50-12, 2-3:30

### Course Description

This course provides an introduction to theoretical computer science. Languages, grammars, and automata will provide a background for a discussion of parsing. Related areas also include recursive definitions, Turing machines, and decidability. Prerequisites: M 221W and CS 115.

The primary focus will be languages restricted by formal rules. The course will cover regular, context-free, context-sensitive and recursively enumerable languages and the automata that recognize them. Students will also study complexity theory and the types of problems that computers cannot solve.

Theoretical Computer Science combines the elegance of Mathematics with the practicality and excitement of Computer Science. It gives you the license to use algorithms, discrete mathematics, graph theory, number theory, probability theory, functional analysis, topology, logic – the list goes on and on. However, you are much more (or much less, depending on your point of view) than an armchair theoretician. You can actually go out and change the way computers are built, operated, or used. A large number of computer science disciplines started out as branches of theoretical computer science: compilers, databases, programming languages, computer security/cryptography, quantum computing, and computational biology all trace their roots back to theoretical computer science. [Source: <http://jonah.cs.elon.edu/sduvall2/courses/csc351/2007spring/index.htm>]

### Course Objectives

- Understand the linkage between discrete mathematics and automata theory with significant emphasis on proofs by construction.
- Able to define the concepts of languages, grammars and automata.
- Able to design, specify and test deterministic and nondeterministic finite automata that recognize regular languages.
- Able to write regular expressions and regular grammars that produce regular languages.
- Able to illustrate the equivalence of deterministic and nondeterministic automata, regular grammars and regular expressions.
- Able to describe the properties of regular languages and prove closure properties under specific operations.
- Able to identify non-regular languages using the Pumping Lemma.
- Able to design, specify and test grammars and deterministic/nondeterministic pushdown automata that recognize context-free languages.
- Able to transform context-free grammars by removing useless productions, lambda productions and unit productions.
- Able to define Chomsky and Greibach normal forms.
- Able to design, specify and test Turing Machines that recognize recursively enumerable languages,
- Understand and able to illustrate various models of turning machines including off-line, multi-tape, nondeterministic and universal.
- Able to explain the hierarchy of languages studied during the semester.
- Familiar with the concept of and able to illustrate problems that cannot be solved by computers and able to illustrate whether a specific language is decidable.

### Course Pre-requisites

M221W and CS115

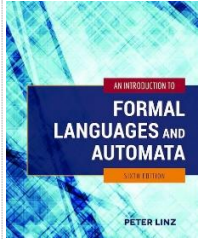
### Expectations

Each student is expected to attend classes and take notes. Read the textbook(s) before attending class. Turn in homework, and other assignments on time. Take quizzes and exams as scheduled. The instructor is available for help during scheduled office hours (check "Instructor Information") and also by appointment. Please do not wait until an exam to get help. Seek help

as soon as possible. You will need to allocate about 9 hours of your week outside of class towards this course. This time will be used for the following:

- reading the chapters in the text book assigned
- completing activities in the text book assigned
- completing homework assignments and the project
- studying for your exams/tests

### Textbook



**Intro to Formal Languages & Automata**  
 AUTHOR: Linz  
 EDITION: 6th  
 COPYRIGHT YEAR: 2017  
 PUBLISHER: Jones & Bartlett Publishers, Incorporated  
 ISBN: 9781284077247  
<http://www.jblearning.com/catalog/9781284077247/>

### Software

Latest version of JFLAP: <http://www.jflap.org/jflaptmp/>

If the file downloads as a .zip file, rename the file back to .jar. Do not unzip. Double-click on jflap.jar file to execute.

### Grading Policy

**Quality Work:** All oral and written work submitted must be of the highest quality. You will be graded on your performance and quality of the work required and not on the amount of time spent nor amount of effort. Any piece of work turned in for a grade is subject to an oral examination and the grade for the work hinges on the result of the student's knowledge, not what is submitted.

### Final Grade:

|             |     |
|-------------|-----|
| Assignments | 50% |
| Tests       | 50% |

|                     |                     |                     |                     |              |
|---------------------|---------------------|---------------------|---------------------|--------------|
|                     | 86.67 to 89.99 = B+ | 76.67 to 79.99 = C+ | 66.67 to 69.99 = D+ |              |
| >= 94 = A           | 83.34 to 86.66 = B  | 73.33 to 76.66 = C  | 63.33 to 66.66 = D  | <= 59.99 = F |
| 90.00 to 93.99 = A- | 80.00 to 83.33 = B- | 70.00 to 73.33 = C- | 60.00 to 63.33 = D- |              |

**Pass/No Pass Option:** Students who are registered with a PASS/NO PASS option must receive a final grade of 65 or better to receive a P.

### Blackboard's "My Grades"

Up-to-date grade information is available 24/7 under "My Grades". It also shows your "Weighted Total". This is your up-to-date, cumulative, weighted grade.

### Assignment Guidelines

**Work independently** All homework assignments are to be worked on independently by each student. Discussions as to what the problem is and very general, top-level solutions are allowed between students. Work may not be copied from another source and will constitute cheating if done so. Any work, or part of your work, that is borrowed from another source must be stated so in the assignment and must be pre-approved by the instructor or preceptor. Failure to do so will constitute plagiarism. All assignment submitted is subject to an oral examination. Upon the request of the instructor, the student will explain (in person) the work submitted. The grade of the assignment hinges on how well the student knows and understands what was submitted.

**Submission** Each assignment must be submitted by following instructions posted on Blackboard. Electronic submissions are due at the end of the day (11:59 pm) on the date due. All assignments must be submitted through Blackboard (View/Complete... link). Do not email your assignment to the instructor; no homework is accepted via email. Similarly, no assignment will be submitted through the Digital Dropbox unless it is pre-approved by the instructor.

**Late Penalty** Any assignment that is late will receive a deduction of 10% every 24 hours (a day). Work that is more than 3 days late will not be accepted. Assignments of which answers have been given will also not be accepted. For

example, if an assignment is due Friday evening and if you turn it in anytime on Sunday, the grade is deducted 20%; any work turned in after the following Monday will receive a grade of 0.

**Test and Examination Guidelines**

All exams are closed book exams and typically take the entire class period. Make up exams will not be given except in cases of extremely extenuating circumstances and are pre-arranged.

**Class Participation Policy**

Even though class participation is not figured into your final grade, your attendance and participation is crucial to your success in this class. The following should give you a guideline on how to actively and positively participate.

| Level of participation | Rubric   |
|------------------------|--|
| A                      | Actively supports, engages and listens to peers (ongoing)<br>Arrives fully prepared at every class<br>Plays an active role in discussions (ongoing)<br>Comments advance the level and depth of the dialogue (consistently)<br>Group dynamic and level of discussion are consistently better because of student's presence                              |
| B                      | Makes a sincere effort to interact with peers (ongoing)<br>Arrives mostly, if not fully, prepared (ongoing)<br>Participates constructively in discussions<br>Makes relevant comments based on the assigned reading material (ongoing)<br>Group dynamic and level of discussion are occasionally better (never worse) because of the student's presence |
| C                      | Limited interaction with peers<br>Preparation, and therefore level of participation, are both inconsistent<br>When prepared, participates constructively in discussions and makes relevant comments based on the assigned material<br>Group dynamic and level of discussion are not affected by the student's presence                                 |
| D                      | Virtually no interaction with peers<br>Rarely prepared<br>Rarely participates<br>Comments are generally vague or drawn from outside of the assigned material<br>Demonstrates a noticeable lack of interest (on occasion)<br>Group dynamic and level of discussion are harmed by the student's presence   |
| F                      | No interaction with peers<br>Never prepared<br>Never participates<br>Demonstrates a noticeable lack of interest in the material (ongoing)<br>Group dynamic and level of discussion are significantly harmed by the student's presence  |

**Student Illness Policy**

The instructor recognizes that students may occasionally become incapacitated by a brief illness or injury and will be unable to attend class or complete a graded assignment or test on time. In the latter case, you are expected to notify your instructor (in advance if at all possible) that you cannot complete the work due to illness or injury.

Following and quoting from the [University of Hartford's Policy of Student Illness](#) as listed on [The Source](#), "the student must:

1. visit the University Health Center, a doctor, or hospital for treatment on the day that you are sick and get documentation of the visit, and
2. email the instructor in advance (or if not possible, within 24 hours of missed class, test, or assignment) to tell his or her that you cannot attend (or complete work) and that you are seeking or have sought treatment.

Allowing you to make up missed tests and assignments is at the instructor's discretion. For extended illness (a week or more), email the academic services office of YOUR college or school. Documentation of treatment is required.

Do not visit the University Health Center after the day you are sick. They will not issue documentation that you were sick on the previous day."

**UH Academic Honesty Policy: Strictly Enforced**

## University of Hartford Academic Honesty Policy

The purpose of the academic honesty policy is to provide a clear statement to students and faculty of the University's expectations regarding academic honesty and to set forth procedures for the enforcement of that policy. The procedures in this academic honesty policy are administrative functions and are not subject to the same rules as in criminal or civil proceedings. Throughout the following policy, the term college refers to any one of the schools or colleges of the University. The term University-wide program refers to programs such as multimedia Web design and development or the Bachelor of University Studies, which do not reside in a college. The term department chair refers to a department chair or, in the case of colleges that do not have departments, the equivalent of a department chair.

- All students are expected to observe generally accepted principles of scholarly writing in all examinations, compositions, papers, essays, tests, quizzes, reports, and dissertations whether written in the class room or outside. Sources of information used by a student in the preparation of work submitted as a basis for credit, or for a grade, or to satisfy graduate or undergraduate thesis requirements shall be clearly indicated in some conventional manner, such as by the use of quotation marks, footnotes, and bibliography.
- Students are forbidden to submit as their own any project, paper, or creative work that is in whole or part the work of another.
- The use of a term-paper writing service is prohibited. Also prohibited is the use of term papers obtained from the Internet, in whole or in part.
- All examinations and quizzes are to be completed without reference to books or notes except when the instructor of a course shall have given explicit authorization for an "open-book examination" or some other specified sort of assistance. Except as authorized by the instructor, no student is to give or receive assistance in the completion of an examination or a quiz.
- Other examples of academic dishonesty include, but are not limited to, the falsification of academic documents, such as transcripts, registration materials, withdrawal forms, or grade reports, as well as the unauthorized reading, removing, or copying of any academic document or record maintained by any member of the faculty or administration.

Your work for this course (assignments, labs, quizzes, tests, exams) must be completed by you - the student - without the help of external sources such as the Internet or a friend. **Googling answers online is NOT ACCEPTABLE and constitutes academic dishonesty.**

**At the first violation of academic dishonesty, the student receives a 0 for the work. On second offense, the student receives an F for the course.**

**A&S Academic Misconduct Policy:** In the event that it is determined that you violated the Academic Honesty Policy, found in "the Source," the dean of your college will be notified and a note will be placed in your permanent file. If previous violations have been filed, any penalty that may be assigned for the offense may be more severe than for a first time offense. If this is the first recorded offense, subsequent violations of the honesty policy may then incur a steeper penalty.

### Email & Blackboard

Course materials (announcements, homework assignments, etc.) will be made available through Blackboard at <http://blackboard.hartford.edu>. Blackboard is to be used as a supplement to class lectures. All important announcements will be made in class. Routine announcements will be made available on Blackboard. However, you are responsible for all announcements and expectations explained in both Blackboard and during class. You are not to rely solely on Blackboard. Your Blackboard account allows you to personalize your information, including your preferred email account. In your "Blackboard Home Page" on the left frame, there is a "Personal Information" link which allows you to edit your information. It is your responsibility to make sure that the email account set here is the one you check regularly and that the Inbox for that email is not rejecting incoming mail.

### Student Illness

The instructor recognizes that students may occasionally become incapacitated by a brief illness or injury and will be unable to attend class or complete a graded assignment or test on time. In the latter case, you are expected to notify your instructor (in advance if possible) that you cannot complete the work due to illness or injury. Following the University of Hartford's Policy of Student Illness as listed on The Source, the student must:

1. visit the University Health Center, a doctor, or hospital for treatment on the day that you are sick and get documentation of the visit,
2. email the instructor in advance (or if not possible, within 24 hours of missed class, test, or assignment) to tell her that you cannot attend (and/or complete work) and that you are seeking or have sought treatment, and
3. as soon as you are able to come to class, bring your documentation of your doctor's visit to your instructor and arrange to make up missed work.

Allowing you to make up missed tests and assignments is at the instructor's discretion. For extended illness (a week or more), email the academic services office of YOUR college or school. Documentation of treatment is required. Do not visit the University Health Center after the day you are sick. They will not issue documentation that you were sick on the previous day.

### Participation & Attendance

Students are expected to attend ALL classes and are responsible for missed classes and lecture materials. Again, you are expected to attend every single class during the semester. Additional material will be provided and covered in class as the instructor deems appropriate. Any material and information you miss is your responsibility. No excuses will be accepted for poor grades. If you must be absent from a class, you must let me know either by phone or e-mail and you are responsible for any material covered or homework assigned. Informing me of your absence does NOT excuse you from any work due that day nor permit you to makeup an exam.

## Computer and Other Electronic Equipment-Use Policy

When classes meet in a room equipped with computers, students are expected to use the computers for the purposes of completing assigned work only. At no circumstances will a student be allowed to surf the Internet, check email during a class, or use the computers for any other purpose. In violation, a student will face serious consequences. Use of any electronic equipment (or otherwise) that is annoying or disrupting is not allowed in class. Such devices include mobile phones, beepers, PDAs, laptops, among others.

## Students with Special Needs

Accommodations are provided only to those students who are registered with Disability Services or student athletes. Please let me know during the first week of class if you qualify for special accommodations.

## Course Schedule:

Live version at:

<https://docs.google.com/spreadsheets/d/1yi7meRnwJK8pdRnNDm2SQMoCNVsj18cZ9LSiO1GGOW/edit#gid=0>

| Week # | Wk Day     | Date          | Topic - Read before class  |
|--------|------------|---------------|--|
| 1      | Tue        | Aug-30        | Chapter 1: Introduction to the Theory of Computation<br>1.1 Mathematical Preliminaries and Notation: Sets, Functions, Relations, Graphs, Trees, Proofs<br>1.2 Three Basic Concepts: Languages, Grammars, Automata<br>1.3 Some Applications<br>Syllabus |
|        | Thu        | Sep-1         | Appendix B: JFlap<br>Chapter 2: Finite Automata  |
| 2      | Tue        | Sep-6         | 2.1 Deterministic Finite Accepters   |
|        | Thu        | Sep-8         | 2.2 Nondeterministic Finite Accepters<br>2.3 Equivalence of Deterministic and Nondeterministic Finite Accepters  |
| 3      | Tue        | Sep-13        | Chapter 3: Regular Languages and Regular Grammars<br>3.1 Regular Expressions   |
|        | Thu        | Sep-15        | 3.2 Connection Between Regular Expressions and Regular Languages<br>3.3 Regular Grammars   |
| 4      | Tue        | Sep-20        | Test Review  |
|        | Thu        | Sep-22        | <b>Test 1</b>  |
| 5      | Tue        | Sep-27        | Chapter 4: : Properties of Regular Languages<br>4.1 Closure Properties   |
|        | Thu        | Sep-29        | 4.2 Elementary Questions about Regular Languages   |
| 6      | Tue        | Oct-4         | 4.3 Identifying Nonregular Languages   |
|        | Thu        | Oct-6         | Chapter 5: Context-Free Languages  |
| 7      | Tue        | Oct-11        | 5.1 Context-Free Grammars  |
|        | Thu        | Oct-13        | 5.2 Parsing and Ambiguity<br>5.3 Context-Free Grammars and Programming Languages   |
| 8      | Tue        | Oct-18        | Test Review  |
|        | Thu        | Oct-20        | <b>Test 2</b>  |
| 9      | Tue        | Oct-25        | <i>TBD</i>   |
|        | Thu        | Oct-27        | Chapter 6: Simplifications of Context-free Grammars and Normal Forms   |
| 10     | Tue        | Nov-1         | 6.1 Methods for Transforming Grammars<br>6.2 Chomsky and Greibach Normal Forms   |
|        | Thu        | Nov-3         | Chapter 7: Pushdown Automata   |
| 11     | Tue        | Nov-8         | 7.1 Nondeterministic and Deterministic Pushdown Automata   |
|        | Thu        | Nov-10        | 7.2 Pushdown Automata and Context-Free Languages<br>7.3 Deterministic Pushdown Automata and Deterministic Context-Free Languages   |
| 12     | Tue        | Nov-15        | Test Review  |
|        | Thu        | Nov-17        | <b>Test 3</b>  |
| 13     | Tue        | Nov-22        | <b>Thanksgiving Break - No Class</b>   |
|        | Thu        | Nov-24        |  |
| 14     | Tue        | Nov-29        | Chapter 9: Turing Machines   |
|        | Thu        | Dec-1         | 9.1 The Standard Turing Machine  |
| 15     | Tue        | Dec-6         | 9.2 Combining Turing Machines for Complicated Tasks  |
|        | Thu        | Dec-8         | 9.3 Turing's Thesis<br>Test Review   |
|        | <b>Mon</b> | <b>Dec-19</b> | <b>Test 4 8am-10am</b>   |