CSCI 4325-01
Automata, Formal Languages, and Computability

Course Information

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<tr>
<th><strong>Instructor</strong></th>
<th>Dr. Tim Wylie</th>
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<tr>
<td><strong>Contact</strong></td>
<td>Office: ENGR 3.287</td>
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<tr>
<td><strong>Office Hours</strong></td>
<td>MW 3:00 p.m. - 5:00 p.m.</td>
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<td><strong>Schedule</strong></td>
<td>Lecture: MW, 9:25 a.m. - 10:40 a.m., ENGR 1.272</td>
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<td><strong>Final Exam</strong></td>
<td>December 13, 2017, 8:00 a.m. - 9:45 a.m., ENGR 1.272</td>
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<tr>
<td><strong>Textbook</strong></td>
<td>Introduction to the Theory of Computation. 3rd edition</td>
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<tr>
<td><strong>URL</strong></td>
<td>[<a href="http://cglab.ca/">http://cglab.ca/</a> michiel/TheoryOfComputation/](<a href="http://cglab.ca/">http://cglab.ca/</a> michiel/TheoryOfComputation/)</td>
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<td><strong>Course Website</strong></td>
<td><a href="http://faculty.utrgv.edu/timothy.wylie/CSCI4325">http://faculty.utrgv.edu/timothy.wylie/CSCI4325</a></td>
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Course Description

**CSCI 4325 - Automata, Formal Languages, and Computability.** The course presents formal computation models. Topics include finite state machine, pushdown state machine, Turing machine, halting problem, definition and properties of formal grammars and their languages as well as theory of computability and complexity including the complexity of optimization and approximation problems. Prerequisite: CSCI 3333 or CMPE 3333 and CSCI 3336.

Course Topics

This course provides an introduction and overview of the history and main areas of theoretical Computer Science. The main areas are formal languages and automata, decidability, and complexity. The study of automata deals with what is possible in a limited machine. With decidability we study problems that can provably not be computed by any machine. For complexity we study Turing machines then how difficult it is to solve individual problems for a given computational model in terms of time and space used. Towards these goals we also review several discrete math concepts, proof methods, logic, and history related to the development of this area. Towards the end we discuss ways of dealing with difficult problems (NP-Hard) with heuristics, approximations, parameterization, etc.

Course Objectives

1. What is computation? This question is related to various computation models and their similarities.
2. What can and cannot be computed? This question is about computability.
3. What can and cannot be efficiently computed? This question is about computational complexity.
4. How are language definition and computability intertwined? This question is about the equivalence of language definition and computational capability.

Learning Outcomes

Upon successful completion of this course, students will be able to:
1. Explain with examples the basic terminology of functions, relations, and sets.
2. Perform the operations associated with sets, functions, and relations.
3. Relate practical examples to the appropriate set, function, or relation model, and interpret the associated operations and terminology in context.
4. Demonstrate basic counting principles, including uses of diagonalization and the pigeonhole principle.
5. Outline the basic structure of and give examples of each proof technique described in this unit.
6. Discuss which type of proof is best for a given problem.
7. Relate the ideas of mathematical induction to recursion and recursively defined structures.
8. Identify the difference between mathematical and strong induction and give examples of the appropriate use of each.
9. Explain the use of big O, omega, and theta notation to describe the amount of work done by an algorithm.
10. Determine the time and space complexity of simple algorithms.
11. Deduce recurrence relations that describe the time complexity of recursively defined algorithms.
12. Solve elementary recurrence relations.
13. Discuss the concept of finite state machines.
14. Explain context-free grammars.
15. Design a deterministic finite-state machine to accept a specified language.
16. Explain how some problems have no algorithmic solution.
17. Provide examples that illustrate the concept of uncomputability.
18. Determine a language’s location in the Chomsky hierarchy (regular sets, context-free, context-sensitive, and recursively enumerable languages).
19. Prove that a language is in a specified class and that it is not in the next lower class.
20. Convert among equivalently powerful notations for a language, including among DFAs, NFAs, and regular expressions, and between PDAs and CFGs.
21. Explain at least one algorithm for both top-down and bottom-up parsing.
22. Explain the Church-Turing thesis and its significance.
23. Define the classes P and NP.
24. Explain the significance of NP-completeness.
25. Prove that a problem is NP-complete by reducing a classic known NP-complete problem to it.

**ABET Outcomes**
1. An ability to apply knowledge of computing and mathematics appropriate to the discipline
2. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
3. An ability to use current techniques, skills, and tools necessary for computing practice

**Course Overview**

**Quizzes.** There will be weekly in-class quizzes during this course. They will be completed during class time and turned in at the end of class. There is no make-up quiz if you miss one. You are expected to attend every lecture.

**Assignments.** Students are expected to have assignments completed at the beginning of class (or when specified) on the due date. This may include selected readings from the textbook.

**Exams.** The material in this course is naturally cumulative, with each week’s topics building on all the prior material. Therefore, each exam will focus on the material covered since the previous exam, however, the student is expected to understand and apply all previous course material.
Scoring and Grading. The purpose of the labs are to increase your hands-on experience with the material, and to provide you with another avenue to demonstrate what you have learned.

<table>
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<tr>
<th>Grade Breakdown</th>
<th>Final Grade</th>
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<tr>
<td>Quizzes</td>
<td>20%</td>
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<tr>
<td>Assignments</td>
<td>30%</td>
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<tr>
<td>Exams</td>
<td>50%</td>
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<td>Total possible score (max):</td>
<td>100%</td>
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90%-100% A
80%-89% B
70%-79% C
60%-69% D
0%-59% F

Note: Grades may be curved to reflect the overall performance of the class.

Course Schedule This is a rough course schedule to give you an idea of topics and pacing. The actual course schedule is likely to change and will be kept up to date on the course website.

Week 1-2: Introduction, mathematical concepts
Week 3-5: Automata and languages
Week 6-8: Computability Theory, decidability
Week 9-13: Complexity Theory
Week 14-15: Topics of interest

Late Work Policy. Labs and exercises will not be accepted late. Assignments must be turned in at the specified time on the given due date. Afterwards, the penalties are as follows:

- Within 24 hours late will lose 10%.
- Within 48 hours late will lose 20%.
- More than 48 hours late will receive 50% credit.

Assignments turned in early will receive an additional 10%.

Make-up Policy. No make-up exams will be given except for university sanctioned excused absences. If you need to miss an exam, it is your responsibility to contact me before the exam, or as soon after the exam as possible. Missing an exam without an approved (by the university or me) excuse will result in a zero.

UTRGV Course Policies

Attendance. Students are expected to attend all scheduled classes and may be dropped from the course for excessive absences. UTRGVs attendance policy excuses students from attending class if they are participating in officially sponsored university activities, such as athletics; for observance of religious holy days; or for military service. Students should contact the instructor in advance of the excused absence and arrange to make up missed work or examinations.

Drop Class Policy. According to UTRGV policy, students may drop any class without penalty earning a grade of DR until the official drop date. Following that date, students must be assigned a letter grade and can no longer drop the class. Students considering dropping the class should be aware of the 3-peat rule and the 6-drop rule so they can recognize how dropped classes may affect their academic success. The 6-drop rule refers to Texas law that dictates that undergraduate students may not drop more than six courses during their undergraduate career. Courses dropped at other Texas public higher education institutions will count toward the six-course drop limit. The 3-peat rule refers to additional fees charged to students who take the same class for the third time. The census date is Sept. 13th, which is the last day to drop the class without it appearing on your transcript, and the last date to drop is Nov. 15th.

Computer Use Policy. Please read and be aware of University policies for computer use and data security, which can be found at: http://www.utrgv.edu/is/_files/documents/utrgv-aup.pdf
Scholastic Integrity Policy. As members of a community dedicated to Honesty, Integrity and Respect, students are reminded that those who engage in scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and expulsion from the University. Scholastic dishonesty includes but is not limited to: cheating, plagiarism, and collusion; submission for credit of any work or materials that are attributable in whole or in part to another person; taking an examination for another person; any act designed to give unfair advantage to a student; or the attempt to commit such acts. Since scholastic dishonesty harms the individual, all students and the integrity of the University, policies on scholastic dishonesty will be strictly enforced (Board of Regents Rules and Regulations and UTRGV Academic Integrity Guidelines). All scholastic dishonesty incidents will be reported to the Dean of Students.

Course Evaluation. Students are required to complete an ONLINE evaluation of this course, accessed through your UTRGV account (http://my.utrgv.edu); you will be contacted through email with further instructions. Students who complete their evaluations will have priority access to their grades. Online evaluations will be available:
- Fall 2017 Module 1 Oct. 5 – Oct. 11
- Fall 2017 Module 2 Nov. 29 – Dec. 5
- Fall 2017 (full semester) Nov. 15 – Dec. 6

Sexual Harassment, discrimination, and violence. In accordance with UT System regulations, your instructor is a “responsible employee” for reporting purposes under Title IX regulations and so must report any instance, occurring during a students time in college, of sexual assault, stalking, dating violence, domestic violence, or sexual harassment about which she/he becomes aware during this course through writing, discussion, or personal disclosure. More information can be found at www.utrgv.edu/equity, including confidential resources available on campus. The faculty and staff of UTRGV actively strive to provide a learning, working, and living environment that promotes personal integrity, civility, and mutual respect in an environment free from sexual misconduct and discrimination.

Students with Disabilities. Students with a documented disability (physical, psychological, learning, or other disability which affects academic performance) who would like to receive academic accommodations should contact Student Accessibility Services (SAS) as soon as possible to schedule an appointment to initiate services. Accommodations can be arranged through SAS at any time, but are not retroactive. Students who suffer a broken bone, severe injury or undergo surgery during the semester are eligible for temporary services.
- Brownsville Campus: Student Accessibility Services is located in Cortez Hall Room 129 and can be contacted by phone at (956) 882-7374 (Voice) or via email at ability@utrgv.edu.
- Edinburg Campus: Student Accessibility Services is located in 108 University Center and can be contacted by phone at (956) 665-7005 (Voice), (956) 665-3840 (Fax), or via email at ability@utrgv.edu.