CSC 483: Theory of Computation -- Spring 2014

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10:10am to 11:00am, MWF, Allen 106A
Office Hours:
by appointment
11:15am-12:00noon, MWF

Current Catalog Description for CSC 483: Theory of Computation
Prerequisites: CSC 203 and MTH 481. 3Cr.
Provides a study of formal languages and theory of automata with an emphasis on Church's thesis and the "algorithm = machine" point of view. Includes these topics: regular expressions and context-free languages, finite and pushdown automata, Turing machines, computability, undecidability, and complexity of problems.

Course Description: The subject matter of this course constitutes the theoretical foundations of computer science. The primary questions addressed are: What is computing? What is computable? While the first question is related to models of computation, the second question is related to complexity of computation. There are two kinds of models of computation: a. language model, b. machine model. The study of these two models of computation and their interrelationships is the sum and substance of this course. As a corollary we will also formalize the concept of "an algorithm".

For a successful completion of this course, you need to have the following prerequisites:

a. Knowledge of high-level programming language such as Java
b. Familiarity with fundamentals of algorithms and data structures (CSC 203 or higher)
c. A good grasp of the contents of topics covered in MTH 481: Discrete Mathematics II. In particular, concepts such as set theory, functions, relations, logic, mathematical proof techniques are very important for this course. Chapter 1 of your textbook deals with these concepts. You are responsible for this material. So, please review and make sure you are comfortable with this material.

JFLP is a software that is built on the concepts involved in this course. It is available as part of this course’s required textbook, and also available for free download from http://www.jflap.org/. This software will be very useful in learning and experimenting with the concepts that will be discussed in this class. So, get it installed in your computer asap.


Reference Books:

Introduction To Automata Theory, Languages, and Computation by John Hopcroft, Jeffrey Ullman, Addison-Wesley.

Evaluation Scheme:

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group-1</td>
<td>5 Homework assignments (5 X 20)</td>
<td>100</td>
</tr>
<tr>
<td>Group-2</td>
<td>1 Midterm</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>1 Final</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>250</td>
</tr>
</tbody>
</table>
Letter grades will be computed separately for groups 1 and 2 as per the following inequalities:

- $60 \leq D^- \leq 62$, $63 \leq D \leq 65$, $66 \leq D+ \leq 69$
- $70 \leq C^- \leq 72$, $73 \leq C \leq 75$, $76 \leq C+ \leq 79$
- $80 \leq B^- \leq 82$, $83 \leq B \leq 85$, $86 \leq B+ \leq 89$
- $90 \leq A^- \leq 95$, $96 \leq A \leq 100$

You must pass each group separately to pass the course. The middle grade between the two letter grades from Group-1 and Group-2 will be the final grade. If there were two middle grades then the higher of the two will be chosen.

**List of Topics:**

1. Deterministic finite automata (DFA), non-deterministic finite automata (NDFA), equivalence of DFA and NDFA, minimization of finite automata.
2. Regular expressions, equivalence of regular expression to finite automata. Closure properties of regular languages. Application of the pumping lemma to prove when a language is not regular.
3. Context Free Grammars, normal forms for grammars, parsing, ambiguity of grammars, equivalence to push-down automata.
4. Turning machines. Alternative models of computation, including include multi-tape, multi-head or non-deterministic Turing machines. Equivalence of these definitions, and the Church-Turing thesis.
5. Universal Turing Machine.
6. The Chomsky Hierarchy.
7. Undecidable problems for Turing Machines, the halting problem, proofs by diagonalization and reduction.
8. Tractable and intractable problems, the classes P and NP, proofs of NP-completeness by reduction.

**Learning Outcomes for CSC 483:**

A student who has successfully completed CSC 483 has the ability to:

1. Understand formal definitions of machine models.
2. Be able to synthesize finite automata with specific properties and understand the use of automata to recognize patterns in text.
3. Be able to manipulate abstract concepts in proofs and cope with abstraction, notations, and transformations between notations.
4. Understand the use of formal descriptions such as grammars to capture patterns in syntax, in particular the syntax of programming languages.
5. Be able to create a formal specification of a grammar from an informal description in English.
6. Be able to convert among multiple representations of a language, such as converting an automaton to a grammar, or a regular expression to an automaton.
7. Understand the different forms automata (deterministic and non-deterministic, with and without various memory devices) and their correspondence with formal languages.
8. Understand the fundamental definition of computation as embodied in a Turing Machine.
9. Understand the different forms and levels of computation and appreciate that there are intrinsic limits to what computations can be achieved on different kinds of automata.
10. Be able to prove the complexity of problems with respect to a variety of levels of computational power (DFA, CFL, TM).
11. Be able to describe concrete examples of undecidable problems.
12. Be able to prove undecidability using the techniques of diagonalization and reducibility.
13. Be able to define and explain the significance of the "P = NP?" question and NP-completeness.
14. Be able to describe concrete examples of NP-complete problems.
15. Be able to prove NP-completeness results using reducibility.

Provisional Dates for:

Homework assignments (due dates): Feb. 14, 28; April 4, 18; May 2.
Midterm: March 14.
Final: Friday, May 16, 10:20 to 12:20am

General Instructions:

Class attendance is a must. 3 absences (with or without permission) will bring down your grade by one grade level.

Homeworks must be submitted (regardless of its status) in hardcopy either word-processed or in legible handwriting.

All due dates end with class times on that day.

Email submissions will not be accepted.

Each homework must have an ID section including the name, number of the homework, date assigned, date due and date submitted, course and section, etc.

For incomplete homework, you need to get my prior permission so you may continue to work on it and resubmit. I will use my discretion in deciding the credit for such late homeworks.

Each homework must be done individually unless otherwise required.

Academic dishonesty of all kinds will be dealt with severely.

No make ups will be offered except under extraordinary situations.

Statement on Sexual Harassment

SUNY Brockport is committed to maintaining a work place and a learning environment free of sexual harassment and intimidation. Sexual harassment is unacceptable behavior, unlawful and intolerable.
Statement on Disability

Students with documented disabilities may be entitled to specific accommodations. SUNY Brockport's Office for Student with Disabilities makes this determination. Please contact the Office for Students with Disabilities at (585)395-5409 or osdoffic@brockport.edu to inquire about obtaining an official letter to the course instructor detailing any approved accommodations. The student is responsible for providing the course instructor with an official letter. Faculty work as a team with the Office for Students with Disabilities to meet the needs of students with disabilities.

I would appreciate hearing from anyone in this class who has a special need, which may be the result of a disability. I am reasonably sure we can work out whatever arrangement is necessary, be it special seating, testing, or other accommodation. See me after class, or during my office hours, as soon as possible.

Emergency Evacuation Policy

All fire alarms, emergency voice notification system messages, etc., are to be taken seriously, especially in this time of heightened security awareness and the potential need to evacuate a building for other reasons such as an emergency response to a spill or other event. Evacuation of the facility is mandatory until the signal to reenter has been given by the Brockport Fire Department, University Police, or Environmental Health and Safety personnel.

Good Luck