CS 454 : Theory of Computation

Instructor: Thoshitha Gamage, Ph.D.
Southern Illinois University at Edwardsville

Summer 2016 Syllabus

Course Information:

Title:	CS 454 : Theory of Computation (3 Credits)
Location:	EB 0140
Time:	TU & TH 10:15 – 12:15 pm
Course Web site:	http://www.cs.siue.edu/~tgamage/M16/CS454

Contact Information:

Office:	EB 3053
Phone ☎:	650-2407
Email ✉:	tgamage@siue.edu
Web Site ⌂:	http://www.cs.siue.edu/~tgamage
Office Hours:	TU & TH 12:15 pm – 02:15 p.m. *or by appointment*

1 Course Objectives

This is an upper level undergraduate class in Theory of Computation. The course objectives are:

1. to introduce formal models of computation and build on the knowledge of CS 330;
2. to understand the fundamentals of computational complexity, limitations of efficient computations, and how to reason about it;
3. to develop an understanding of what can be computed efficiently;
4. to develop the skills to formally reason about computational complexity through abstract machines; and
5. to develop essential problem solving and critical thinking skills requisite of a computer scientist.

2 Course Prerequisites

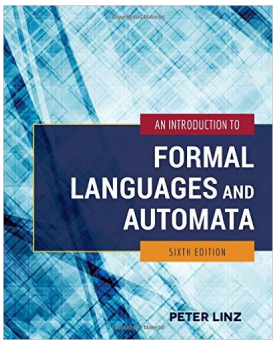
CS340 or instructor's consent. Contact me immediately **within the first week** and get my approval if you don't meet the course prerequisites. I reserve the right to drop you from the course if it becomes obvious that you do not meet the course prerequisites.

3 Textbook & Resources

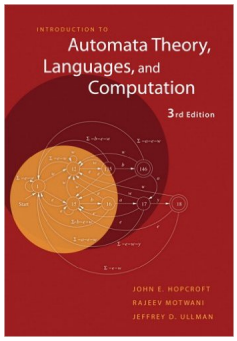
No particular textbook is designated as required for this course. That said, it is **strongly recommended** to get hold of **one** of the following textbooks to supplement your learning and for your reading reference. Given that this is a theoretical class by nature, any one of these very good textbooks will serve the purpose of the course.

- **[PL6e]** An Introduction to Formal Languages and Automata, 6^{th} ed., Peter Linz, Jones & Bartlett Learning, ISBN: 978-1284077247
- **[HMU3e]** Introduction to Automata Theory, Languages, and Computation, 3^{rd} ed., Hopcroft et al., Addison Wesley, ISBN: 978-0321455369

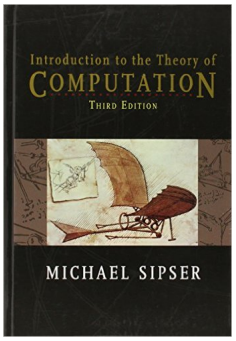
- **[MS3e]** Introduction to the Theory of Computation, 3^{rd} ed., Michael Sipser, Course Technology, ISBN: 978-1133187790
  [Required Video Lecturing] In preparation for each lecture, you are **required** to watch Professor Ullman's (one of the **HMU3e** authors) video lectures found on his Youtube channel `https://goo.gl/qxWlZ8`. This is a mandatory requirement to participate and to earn credit for the in-class problem solving sessions.



(a) **[PL6e]**



(b) **[HMU3e]**



(c) **[MS3e]**

4 Assigned Work and Tentative Grading Policy

The following grade allocation breakdown is ***tentative***, and may change during the semester. Unless the circumstances change, I am **NOT** planning on curving the final grade.

Grading Allocation		**BS**	**MS**
Exams		60%	55%
Midterm 01	15%		
Midterm 02	15%		
Final *(comprehensive!!)*	30% / 25%(MS)		
Attendance & Scribing		5%	5%
Problem Solving		35%	25%
Graduate Standing Project		–	15%

Final Letter Grade	
90–100	A
80–89	B
70–79	C
60–69	D
below 60	F

4.1 Exams

All exams and quizzes will be held in the lecture room.

Midterm 01: Tuesday June 21^{st} 10.15 – 11.00 a.m.
Midterm 02: Tuesday July 19^{th} 10.15 – 11.00 a.m.
Final: Thursday August 04^{th} 10.15 – 12.00 p.m.

4.2 Class Participation

You are expected to **proactively** participate in in-class discussions. This aids your learning and that of your classmates, and provides valuable feedback on the lecture. Constructive and proactive participation in in-class discussions and scribing accounts for 5% of your final grade. I, therefore, expect you to attend each and every class. Each student is required to submit their scribe notes at least **two** times during the course of the semester. Scribe notes are due through *Moodle* within **48 hours** after the lecture. Only the top two scribe submissions (based on Moodle timestamp) will be counted as valid.

Scribe notes serve as a baseline set of complementary notes to you and your colleagues, hence please do your due diligence to make them readable. Students are also **required** to check the course website and the SIUE email account regularly for any important updates.

4.3 Problem Solving

There will be roughly ~6-7 in-class problem solving sessions. In preparation, students are **required** to watch the relevant video lectures from Professor Jeff Ullman's Youtube channel https://goo.gl/qxWlZ8. I have noted down and outline of the relevant videos and sections from the recommended textbooks. I am expecting you to follow the videos (and the readings) closely.

4.4 Graduate Standing Project

Graduate students are required to conduct a mini-research project related to theoretical computer science (especially complexity theory) that is worth 15% of the final grade. Ideally, your topic should be relevant to your current research interest/MS thesis/MS project but approaching it from a theoretical perspective. Some topics of interest to the instructor are state space explosion in model checking, topological combinatorics, network protocol correctness verification, and modern applications of category theory.

- Tuesday June 21^{st}, 2016 – The title of the your research project. Due at the beginning of class.
- Tuesday July 12^{th} 2016 – A one page research progress summary. Due at the beginning of class.
- Thursday July 28^{th} 2016 – Project Presentation slides. Due through Moodle by the end of the day.
- Tuesday August 02^{nd} 2016 – Final report. Due at the beginning of class.

Places to look for a research topic includes (but not limited to) IEEE Symposium on Foundations of Computer Science (FOCS), ACM Annual Symposium on the Theory of Computing (STOC), ACM-SIAM Symposium on Discrete Algorithms (SODA), IEEE Conference on Computational Complexity (CCC). Implementations and empirical evaluations are **highly favorable** over other types of projects.

You are to present your research to the class at the conclusion of your research during week 10. In addition, you are required to produce an IEEE conference style minimum 6-page paper of your research. A template can be found at http://www.ieee.org/conferences_events/conferences/publishing/templates.html. You are **highly encouraged** to produce your report using Latex. A typical graduate level research of this scope would include a bare-minimum 20-25 *highly cited* research papers. I reserve the right to decide which projects meet graduate standing and lower the grade for those who don't, thus make sure to clearly exchange your research ideas with me and clarify your doubts about my expectations **early** in the semester.

In addition, graduate students may have additional mandatory questions in exams. Accordingly, graduate students will be graded on separate scale. Please refer Section 4 for the scale.

5 Course Requirements and Policies

5.1 Attendance Policy

For unforeseen circumstances, there will be times when you are unable to attend the lecture. Thus, I allow you to miss at most 2 classes for the semester without any penalties. Medical emergencies are outside this "absentee allowance", but should be accompanied by proper documented proof of medical services. For planned absences, assignments should be turned in before the absence, rather than after. I reserve the right to lower the grade of any student who is markedly deficient in attendance and/or in in-class participation. If you miss a class, it is *your* responsibility to find out what happened and to collect any material that was handed out in the class.

5.2 Late Policy

Unless otherwise noted or announced in-class, any take home assignments (Leftover questions from problem solving sessions for example) are due within a week at the beginning of the next immediate class. Assignments may be turned in after an additional 48 hours of the due date with a 20% late penalty. No assignment is accepted beyond that.

5.3 Responsible Learning Policy

I expect *you* to *own* your degree of success in this class *and*, I expect you to contribute to the success of others. Examples:

- Read outside the class on your own in preparation for each lecture, jot down any questions your encounter on your reading (strongly encouraged), and bring those to the class as discussion points;
- Be respectful of the learning environment. Refrain from activities that may disturb the flow of the lecture or the environment;
  - Do not engage in disruptive *"little talk"* while I am conducting the lecture; if you have a concern, raise your hand and grab my attention. be respective of your colleagues time and desire to learn.
  - Put your cell phones to vibrate mode and refrain from using your computers for casual web browsing. Take full advantage of the opportunity to learn.
- Cooperate with other students and to share your knowledge during in-class discussions. Respect the differences in learning and understanding of each other. Seek ways of taking advantage of those differences;
- If another student is confused, help him or her out without disturbing the class;
- I enjoy engaging in technical conversations with students with the goal of helping them create an accurate understanding of course material. Participating in such conversations is very favorable for your class participation grade;
- If I am systematically doing something that inhibits your learning, tell me;
- Engage in *proactive learning*: speak up when you don't understand, question assumptions, relate course material to your experience outside class, seek out additional experience and reading related to the class. You must *construct* your understanding of the material;
- If a lecture point is unclear, ask questions and ask me to repeat what I said, preferably in class, during office hours, or by e-mail. You are probably not alone in your confusion;
- Promptly review feedback you receive from me or other students to actively clarify the feedback if the material is still unclear and to incorporate the feedback in your future work;
- Spend adequate time on the course. Adequate time includes getting enough rest so that time you spend on course tasks is well-spent time. Adequate time includes proofreading and reviewing your assignments before you hand them in;
- Have high expectations of yourself: set goals for yourself and try to do your very best. Consciously think about the balance between what you do to earn a grade and what you do to learn (If I'm doing something that puts these in opposition to each other, please let me know.); and,
- Check your SIUE assigned student email and the course website regularly for important class announcements.

IMPORTANT: I strongly discourage you from getting into discussions with me about grades and how you can get a better one. This includes emailing me about possible ways to "bump" your grade. Such requests only mean one thing; that you have already fallen behind on your own expectations.

5.4 Academic Dishonesty: http://www.siue.edu/policies (3C1 & 3C2)

Do your own work. Your exams, homeworks, and programming projects are subject to the academic honor code. **DO NOT CHEAT IN ANY WAY: DO YOUR OWN WORK!**. Following activities will be considered academic dishonesty:

- Submitting work (such as homework assignments projects, and code) done by somebody else (this includes any human/electronic sources (such as web sites));
- Watching and copying your neighbors' solutions during quizzes and/or exams;
- Using materials not allowed during quizzes and exams;
- Using materials not allowed for the programming projects.

It is quite acceptable to ask others things like "Have you come across this particular issue/error/exception before?," and even having them briefly look briefly at your stack trace and/or its code. To have them spend hours helping develop or seriously rearrange your program's logic, on the other hand, is not acceptable. And, of

course, it is unacceptable for two or more people to collaboratively develop the solutions to assignments. If you are tempted to collaborate on such assignments, **DON'T!!**.

I expect you to know and observe the SIUE Student Conduct Code (3C1) and Student Academic Code (3C2). Copying of other students' work, working together on individual assignments, plagiarism of published sources and other forms of academic dishonesty will result in zero credit on the assignment for all students involved and a lower grade in the class. A second offense (across the University) will result in an automatic **F** in the course and exposes the violator to University sanctions up to and including expulsion. All offenses will be reported to Student Affairs.

5.5 Disability Support Services: http://www.siue.edu/dss

Any student inquiring about academic accommodations because of a disability should contact Disability Support Services so that appropriate and reasonable accommodative services can be determined and recommended. Disability Support Services is located in Student Success Center, Room 1270. Their phone number is 650-3726 and their email is disabilitysupport@siue.edu.

6 Tentative Schedule*

*Subject to adjustment and Change. I reserve the right to change topics or add an item of related interest. All changes will be announced in class.

Week	Dates	Topics	References	Assignments/Exams
01	May. 31, Jun. 02	Introduction and Course Overview **Regular Languages:** Deterministic Finite Automata (DFA)	**MS3e**/1.1 **PL6e**/2.1	Video 1-2-2 & 1-3-3 **PS01**
02	Jun. 07, 09	Non-Deterministic Finite Automata (NFA) Regular Expressions (RE), Closure Properties and Equivalences	**MS3e**/1.2-3 **PL6e**/2.2-3, 3.1	Video 1-4-4 Video 2-1-5 & 2-2-6
03	Jun. 14, 16	Non-Regular Languages, Pumping Lemma **Context-Free Languages (CFL):** Context-Free Grammars	**MS3e**/1.4 **MS3e**/2.1	Video 2-4-8 & 3-1-9 **PS02**
04	Jun. 21, 23	**MID-TERM EXAM #01** Normal Forms	**PL6e**/6.1-2	Video 3-3-10 & 3-3-11
05	Jun. 28, 30	Push-Down Automata Pumping Lemma for CFL	**MS3e**/2.2-3 **PL6e**/7.1-3	Video 3-4-12 & 4-2-14 **PS03**
06	Jul. 05‡, 07	CFL Properties and Equivalence **Recursively Enumerable Languages (REL):** Recursive vs. REL	**MS3e**/2.4 **PL6e**/8.1-3	Video 4-1-13
07	Jul. 12, 14	**Turing Machines (TM)**:	**MS3e**/3.1,3.3 **PL6e**/9.1, 9.3	Video 4-4-16 & 5-1-17 **PS04**
08	Jul. 19, 21	**MID-TERM EXAM #02** Halting Problem, **Computational Complexity:**	**PL6e**/12.1-2 **MS3e**/4.1,2	Video 5-2-18
09	Jul. 26, 28	Undecidability, Diagonalization Principle Satisfiability, NP-Completeness	**PL6e**/14.3-6 **MS3e**/7.2-4	**PS05** Video 5-3-19 & 6-2-21
10	Aug. 02, 04	*MS Research Presentations: Topics TBA* **Final Exam: 10.15 – 12.00 p.m.**		

PSXX – Problem Solving #XX
MS PR – MS Research Project