CISC 603: Theory of Computation

SUMMER 2021 (Executive)

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Office Hours: By appointment via email
Term Dates: 5-8-2021 to 8-13-2021
Final Grades Posted by 8-30-2021
Online Meetings: Thursday from 6 PM – 7 PM EST via Adobe Connect
Executive Meetings: 5-8-2021, 6-12-2021, & 7-31-2021

CATALOG DATA

Computation is what computers do; read a program, that reads some input, and eventually produce the right output. Theory of Computation (or Theoretical Computer Science) is the study of the mathematical models of computation used to define the abstract computer (by Alan Turing), how to use them as a base to understand the problem solving API stacks of algorithms, and programming languages used by todays computing platform to solve complex real world problems. To have a good grasp of such concepts we need to the right environments where such sort of processes to occur. The basic ingredients for such environment are a machine capable of performing the computation, a language for writing instructions that the machine can understand, and a program written in that language, describing the exact computation that the machine should perform. We will investigate these three ingredients, what they are, how they behave, how we can model and study them, and how we can exploit them to get useful work done. We will start with the simplest model, a regular expression and show how adding components like memory and data structures will increase computational power till we reach most powerful machines and their limitations. The ultimate goal of this course is to help the students to answer the most common but frustratingly constrained questions of, given a task;

1) Is it solvable? Like can it be carried out using a computer? This requires a solid math proof.
2) What resources are needed to solve it? We need an accurate complexity measure for that.
3) What is the most efficient way to implement the solution? This requires the right computing environment including the architecture, the programming language, and the method.

The word “constrained” relates to “Constraint Satisfaction” is a key concept that will help students how to best answer the above questions mostly in a specific domain of problems, language, and architecture.

COURSE PREREQUISITE

- CISC 530 (Computer Architecture for Software Engineers), and
- CISC 610 (Data Structures and Algorithms)

EXPECTED KNOWLEDGE AT THE START OF THE COURSE

Student’s background preparation should include a solid set of fundamental mathematical skills, including basic set theory, discrete math, and mathematical proof techniques. Basic knowledge of algorithm design and analysis, graph-theoretical, sorting, and pattern-matching algorithms are expected. Ability to have mastered a high-level programming language (e.g., C++, Java, …) is highly desired, although not critical.

PROGRAM EDUCATIONAL OBJECTIVES AND ASSESSMENT METHOD

- Program Educational Objectives covered: [1], [2], and [3].
- Assessment Method: Locally Developed Exams and assignments applying related theories.

EXPECTED KNOWLEDGE GAINED AT THE END OF THE COURSE

A student who successfully fulfills the course requirements will be able to demonstrate:

- Apply the different concepts in automata theory and formal languages to solve real world problems; [1, 2]
- Prove the properties of languages, grammars and automata with rigorously formal mathematical methods; [1, 2]
- Design automata, regular expressions and context-free grammars accepting or generating a certain language; [3]
- Describe the language accepted by an automata or generated by a regular expression or a context-free grammar; [3]

TEXTBOOKS and REFERENCES

- Peter Linz, "An Introduction to Formal Languages and Automata" – 6th Edition. Jones & Bartlett Learning. (**Primary**)
- Rosen, K. H., "Discrete Mathematics and its Applications", 7th Edition, McGraw-Hill Publishing. (**Supplemental**)
- Lecture notes, handouts, URLs, Papers, Codes, and online references will be provided by the professor.

NOTE STUDENTS WITH DISABILITIES

It is Harrisburg University's policy is not to discriminate against qualified students with documented disabilities. It is also your instructor's policy to try to help students learn by whatever reasonable means necessary. If you have a disability related need that requires a modification in your testing situation, please notify your instructor a week before the first test or quiz so that your need can be accommodated. You may be asked to present documentation that describes the nature of your disability and the recommended remedy.

CLASS CONDUCT AND POLICIES:

1. **Classes will start on time** and end as scheduled. Please be there time, and try as much as you can not to miss a class otherwise you are going to miss a lot.
2. **Do not submit a .rar or .zip files on Canvas**. I will take this as an attempt to avoid the built-in software that is tracking plagiarism and give you a zero for the assignment. No reconsideration will be made.
3. You will attend each class and **actively participate** in the discussions during class. If you are uncomfortable with public speaking, or if English is not your native language, please talk to the instructor in the first two weeks of the course to establish ways to make you more comfortable in speaking and interacting with other students (your peers).
4. Online sessions are optional but highly encouraged. A recording of any executive session will be uploaded, as well as the other lectures. Weekly online sessions are a good time to discuss any questions or concerns you may have with your professor. Note that weekly online sessions are not recorded.
5. **You are responsible for all the readings**, even if the material is not explicitly covered in class.
6. You should read the class materials prior to class and be prepared to discuss and ask questions about the readings and assignments. You should also re-read the material after class as not every topic will be covered during class time.

7. I anticipate that for each lesson you will need to budget about ***4 hours. 8 hours*** are anticipated for any project, and with your test preparation, this implies that you need to budget about ***120 hours*** of out-of-class time over the course of the semester. This time estimate is a guide and **you may need to budget more**. For example, if the material is new to you or difficult to comprehend, it will require more of your time.
8. All communications with the instructor should be done using Harrisburg's electronic mail service. Any email sent a different mail system, or through the integrated Canvas messaging system, will **NOT** be answered.
9. **All assignments are individual** unless noted otherwise.
10. There is a zero tolerance **plagiarism policy** for this class. As an example, if **40%** of the content submitted for your assignment is not original or your own, I will investigate and deduct points as needed. Any submission over **50% unoriginal content** will not be graded and will receive a zero. You will not have an opportunity to resubmit the assignment if you receive a zero due to unoriginal content. Reconsideration will not be allowed. Do not ask. Note the percentage values are used only to illustrate the logic behind investigation of academic dishonesty and should not be used as a rule or metric of your submissions. No degree of academic dishonesty is permitted.
11. Late assignments (submitted after the due date) will be deducted **1% for each day** submitted late unless prior arrangements have been made, via email with the professor, and a comment is added to your submission. After 3 days, a **non-reversible zero** will be entered for the assignment. Resubmissions for any late assignments will not be accepted.
12. All homework and exam submissions **must** be typed and submitted in a Word Document (.DOC / .DOCX), including responses to any prompts or assignments. Hand-written or image submissions **will not be accepted**, except in the case for complex diagrams. In the case of complex diagrams, you may hand draw them and import them into your digital document (typically done by taking a picture, cropping it, and organizing your diagrams with the responses). You **must** write your name and date under the diagram as proof of their originality and your ownership. Any hand-drawn image or diagram that does not have your hand-written name will not be graded.
13. Your professor invests a significant amount of time reviewing and grading your submissions. If they are illegible, disorganized, or incoherent, points will be deducted. Please ensure your submissions are in English and that proper grammar is utilized.
14. If the course follows the executive format, **you must be in attendance** (i.e. in-person) to complete and submit the mid-term and final exams. No exceptions.
15. The assignment schedule is released at the beginning of the course, so plan your assignment submission accordingly. No last minute extensions will be granted.

EXAMS DESCRIPTIONS, GRADING, AND FEEDBACKS

Multiple activities build up your final grade in this course:

- **Unit Assignments –** There will be six (6) individual assignments worth 3% each and constitutes 18% of your final grade. Homework will be graded based on effort rather than correctness as they are intended as a study aid for the exams, using the following grading scheme:
  - **3%** for a good-faith effort (all problems attempted)
  - **2%** for good effort (not all problems attempted, adhering to all course policies)
  - **1%** for some effort (not all problems submitted and / or submitted late)
  - **0%** for unintelligible, late, plagiarized (over 50%), unsubmitted homework, or not adhering to all course policies).

  Solutions will be posted to the Canvas homepage after the submission window has closed (typically 3 days after due date) so that you may review your responses.
- **Exams –** There will be two (2) cumulative exams, a mid-term exam worth 30% and final exam worth 42% of the final grade. You will have 3 days to take the exam and up to 1 hour to complete them.
- **Participation –** Participation in the course consists of posting and responding in the discussion forum and accounts for 10% of the final grade.

Grade Breakdown:

Grade	Quantity	Each	Total
Assignments	6	3 %	18 %
Participation	1	10 %	10 %
Mid-Term Exams	1	30 %	30 %
Final Exam	1	42 %	42 %
		Total	100 %

Grading Scale:

Letter Grade	Range
A	90.0 – 100%
B	80.0 – 89.9%
C	70.0 – 79.9%
F	<= 69.9%

PROBLEMS ARISE

Problems happen to people when they are least expected. If any problems arise that you expect could impact your work in this class -- **PLEASE CONTACT ME AS SOON AS POSSIBLE! I want to see every student succeed -- but I can only help if I know as soon as possible!**

Last Modified: 1-3-2021

STATEMENT ON ACADEMIC INTEGRITY

According to the University's Student Handbook: Academic integrity is the pursuit of scholarly activity free from fraud and deception and is the educational objective of this institution. Academic dishonesty includes, but is not limited to cheating, plagiarism, fabrication of information or citations, facilitating acts of academic dishonesty by others, unauthorized possession of examinations, submitting work of another person, or work previously used without informing the instructor, or tampering with the academic work of other students. Any violation of academic integrity will be thoroughly investigated, and where warranted, an action will be taken. Students should be aware that standards for documentation and intellectual contribution may depend on the course content and method of teaching and should consult the instructor for guidance in this area.

Honor Code - We as members of Harrisburg University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work. As a Community of Learners, we honor and uphold the ***HU Honor Code***.

Plagiarism Sanction Policy - Per the Student Handbook, if accused with plagiarizing any graded item, the first step is for you to communicate with your course instructor (step 01 in below). It is up to the instructor to discern if an Academic Code of Conduct violation has taken place using the preponderance of evidence and apply the following sanctioning procedure:

1. Revision and resubmission of an assignment: Respondent is permitted to revise and resubmit the assignment, but with written record of the violation of conduct.
2. Educational assignment or reflection assignment: Respondent is responsible for completion of an educational or reflective assignment.
3. Remedial training and assessment: Respondent is responsible for the completion of an online training module offered through the Office of Student Services;
4. Zero (0) Grade: Assignment of a grade of zero (0) for the assignment, test, quiz, presentation, etc.; and/or
5. Failure of course: The student will be administratively withdrawn from the course with a grade of a "WF".

The “administrative action” when an Academic Code of Conduct Violation is to notify Student Services and report using the following link: https://harrisburgu-advocate.symplicity.com/public_report/

All Academic Code of Conduct Violations will be reported, and a tracking system will be maintained to flag future violations which may increase the sanctions if there is existence of prior conduct violations. The student will then have five days to appeal the decision with Student Services. Student Services may find the appeal frivolous or without merit, or it may refer it to the Academic Dishonesty Appeal Committee. If no appeal is received within the five day timeframe, the case is closed and the sanction stands.

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CLASS SCHEDULE

This list represents the initial plan for CISC 603. Please note that it is merely a *plan*. Actual dates may change due to weather, illness or other unforeseen problems. Changes will be announced posted on the course's news forum. Assignments are due **Sunday @ 11:55 PM EST** on the stated due date.

Week	Topic	Reading Linz 6th Edition	Homework Assignment	Section	Problems	Due Date
1	Review					
	Executive Session 1: Syllabus Review, Fundamentals, Ch. 1 - 2					8-May
2	Mathematical Foundations	Ch. 1	1	§ 1.1	#1 – 8	30-May
3	Languages, Grammars, Automata			§ 1.2	#1 – 5	
4	Finite Automata	Ch. 2	2	§ 2.1	#1 – 5, 9	9-Jun
				§ 2.2	#1 – 3, 9	
5	Equivalence and Reduction			§ 2.3	#1 – 3, 8, 9	
				§ 2.4	#1, 2	
	Executive Session 2: Mid-term Exam	Ch. 1 & 2				12-Jun
6	Regular Expressions, Regular Languages	Ch. 3	3	§ 3.1	#1, 3, 5, 7	27-Jun
				§ 3.2	#1 – 3	
7	Context-Free Languages	Ch. 5		§ 5.1	#1 – 5	
				§ 5.2	#1 – 5	
				§ 5.3	read	
8	Transforming Grammars, Normal Forms	Ch. 6	4	§ 6.1	#1, 3, 5	11-Jul
				§ 6.2	#4, 5, 12	
9	Pushdown Automata	Ch. 7		§ 7.1	#1, 2, 5, 7	
				§ 7.2	#1, 3, 5, 7	
10	Turing Machines	Ch. 9	5	§ 9.1	#2, 3, 4 – 7	25-Jul
11	Limits of Algorithmic Computation	Ch. 12		§ 12.1	#1, 4, 6	
				§ 12.2	#1 – 3	
				§ 12.3	#1, 4, 5	
	Executive Session 3: Final Exam	Ch. 1-3, 5-7, 9, 12				31-Jul
12	Computational Complexity	Ch. 14	6	§ 14.1	#1, 2	8-Aug
				§ 14.2	#1 – 4	
				§ 14.3	#2, 3	
13	P, NP, and NP-Complete Problems			§ 14.4	read	
				§ 14.5	#1 – 2	
				§ 14.6	#1 – 2	
				§ 14.7	#1 – 3	

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