HARRISBURG UNIVERSITY
OF SCIENCE AND TECHNOLOGY

# CISC 603: Theory of Computation

**Instructor**: Daqing Yun, Ph.D., DYun@HarrisburgU.edu
**Meetings**: As posted in the Canvas page
**Office Hours**: Canvas Discussion Forum or by Email[1]

## 1. Course Overview

This course contains abstract models of computation and computability theory including formal languages, finite automata, regular expressions, context-free grammars, pushdown automata, Turing machines, primitive recursive and recursive functions, and decidability and un-decidability of computational problems. The ultimate goal of this course is to help the students to answer the most common but frustratingly constrained questions of, given a task. For example, given a problem/task,

- Is it solvable? Can it be carried out using a computer? This requires a solid mathematical proof;
- What resources are needed to solve it? We need an accurate complexity measure for that;
- What is the most efficient way to implement the solution? This requires the right computing environment including the architecture, programming language, and the methods.

## 2. Important Rules

- All work must be completed and turned in through Moodle system and ***email submissions will be discarded and will not be graded***.

## 3. Course Prerequisites

- CISC 530: Computing Systems Architecture
- CISC 610: Data Structures and Algorithms

## 4. Expected Knowledge at the Start of the Course

Students should have certain background in fundamental mathematical skills, including basic set theory, mathematical proofs, graph theory, etc. Knowledge of algorithm design and analysis are also expected. Intermediate level in one of the general purpose programming language (e.g., C/C++, Python, Java, etc.) is highly desired, although not critical.

## 5. Program Educational Objectives and Assessment Method

- Program Educational Objectives covered: [1.1], [2.2], and [3.1].
- Assessment Method: Locally Developed Tests, and a DSL Project (optional).

## 6. Expected Knowledge Gained (Course Objectives)

By the end of this course, students should be able to:

- Demonstrate an adequate level of system modeling, and advanced qualitative and quantitative problem-solving skills [1.1];
- Apply high level logical synthesis converting a higher-level form of a design into a lower-level implementation, and automate design process that interprets an algorithmic description of a desired behavior [2.2];
- Create virtual environments and computing pipelines required to solve problems in a specific domain [3.1].

## 7. Textbooks and References (Not Required)

- **[Sipser]** M. Sipser. *Introduction to the Theory of Computation* (3rd Ed.), 2012, ISBN: 978-1133187790.

[1] Please include "CISC 603+Your Class Session#" in the subject line when sending emails to me.

- **[GJ]** M.R. Garey and D.S. Johnson. *Computers and Intractability: A Guide to the Theory of NP-Completeness*, 1979, ISBN: 0-7167-1044-7.
- **[DPV]** S. Dasgupta, C. Papadimitriou, and U. Vazirani. *Algorithms*, 2008, ISBN: 0073523402.
- **[JS]** R. Johnsonbaugh and M. Schaefer. *Algorithms*, 2003, ISBN: 0023606924.
- **[WS]** D. Williamson and D. Shmoys. *The Design of Approximation Algorithms*, 2011, ISBN: 0521195276.
- **[Stuart]** T. Stuart. *Understanding Computation: From Simple Machines to Impossible Programs*, 2013, ISBN: 978-1449329273.

**8. Course Conduct**

- ***Attending live sessions*** and actively participate in the discussions is highly recommended as it is where basic concept of each unit is explained, assignments are discussed, and your questions are answered. I anticipate that you will need 2 to 3 hours to budget for solving weekly assignments. You are responsible for all the readings, even if the materials are not covered explicitly in class. 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. Many passages in the text may need to be reviewed several times to gain clarity. Also, taking notes on the material you are reading and reflecting on the reading and these notes will help you better understand the issues, concepts and techniques that are being presented.
- All class credit-related email communications must be done using **HU's electronic mail** service and the student's assigned Harrisburg University ID. By "credit-related", I mean everything that is related to course credits. Emails sent through other mail systems will be discarded. All homework assignments will be assigned individually unless particularly mentioned otherwise, ***duplicate and similar submissions will be considered as plagiarism***.
- Students who participate in University-sanctioned events (such as athletics) must make prior arrangements and give the instructor ample notice. Missing class for practice is not advised.

**9. Evaluation**

Your grade includes the following grading components:

- Class participation: 10%
- Assignments: 30% (evenly distributed)
- Project: 15% (evenly distributed)
- Midterm: 20%
- Final: 25%

Your grade will be assigned using the following grading scale (***no rounding, e.g., 69.99 is an "F" grade***):

- A: >= 90%
- B: >= 80%
- C: >=70%
- F: < 70%

**NOTE**: Final grades will **NOT** be curved unless necessary. I will feel free to give an F to any student who clearly did not put effort into the course (or an A to any student with truly exceptional performance). All grades become final after they are submitted to the register office. There will be no exceptions. If a student wishes to challenge any grade, he or she must do so in writing (not in person), with a concise and objective explanation for why the grade should be changed. This explanation should be submitted to the instructor by e-mail.

**10. Class Participation**

We will have on-line meeting on a weekly basis. Students are expected to: i) join on time; ii) stay until the end of class; iii) participate in the middle. There will be several attendance checks. Note that I may take attendance at any time of a lecture meeting.

**11. Exams**

Makeups will only be given under extreme circumstances and if I approve the absence ***before*** the quiz/exam is given. All excused absences must be documented (e.g., with a doctor's note). Please consult the schedule, which is/will be posted on Moodle, to see when the assignments, presentations, and exams are scheduled.

**12. Notes to Students with Disabilities**

It is Harrisburg University's policy not to discriminate against qualified students with documented disabilities. It is also your instructor's policy to try and 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.

**13. Inclement Weather and Unscheduled Closing Policy**

In the event of an extreme event (weather, power, etc.) that would cause the official closing of the University and normally result in the cancellation of classes, the instructor may choose to move class activities online. Check the Moodle course page for specific directions on when and how to participate in class during extreme events. Online, synchronous courses will be held regardless of extreme events, unless the event interrupts electricity for the instructor or a majority of students. Check the Moodle course page for specific directions on how to participate in an online, synchronous class during extreme events. Online, asynchronous courses are not impacted by extreme events unless otherwise indicated by the instructor.

**14. HU Core Competencies**

At the conclusion of this course a student will meet the following core competencies that reflect HU's mission:

- Critical thinking and problem solving skills are demonstrated by the student's ability to:
  - Identify and clarify the problem.
  - Gather information.
  - Evaluate the evidence.
  - Consider alternative solutions.
  - Choose and implement the best alternative.
- **Communication**. The core communication skilled are demonstrated by the student's ability to:
  - Express ideas and facts to others effectively in a variety of formats, particularly written, oral, and visual formats.
  - Communicate effectively by making use of information resources and technology.
- **Teamwork and Collaboration**. The students will be working with others to increase involvement in learning and by sharing one's own ideas and responding to others' reactions to sharpen thinking and deepen understanding.
- **Information Technology**. The students will be making effective use of the .NET information resources and technology.
- **Competency Assessment**. Prerequisite Problem Solving and Critical Thinking Skills Assessment Testing II (PSCT SAT II) will be used to evaluate your level of proficiency in an HU core competency http://www.harrisburgu.net/academics/core-competencies.php directly connected to that assignment. The students are allowed multiple attempts to pass the test, which is offered two or three times during the first three weeks of the semester. Students receive credit towards their grade in Discrete Mathematics (II), up to 5%, which is half a letter grade. Credit is only received for a passing score on the test. A passing score is a minimum of 70%. The students are lectured and provided with the three documents. The first was the lists of the prerequisite skills that will be covered in the test. The second document is a practice test with 12 problems. The third document was the rubric used for grading the test. The 12 problems cover concepts carefully selected to encourage students to prepare for Discrete Mathematics (II) by reviewing necessary prerequisite knowledge. The first opportunity students have to take and pass the test is during the second class meeting of the semester. The test is administered in-

class, and most students are easily able to complete the test within the sixty minutes' duration. The tests are to be graded, and students finds out if they passed the test via e-mail or grade postings on Moodle. The third class meeting, students receive their graded answer sheets with incorrect answers noted. The students do not receive the test question sheets, though, so the test may be used again during subsequent semesters. Students are welcomed and encouraged to review the test questions and their work in the instructor's office or the TA, but the test questions are again retained. Subsequent opportunities to pass the test are provided after the midterm. All questions are in the same order as the prerequisite problem solving and critical thinking skills list and practice test, and the content of the questions changes only slightly for each test. Therefore, students should expect no surprises when taking each test. While no in-class review is provided, one or two out-of-class review sessions are held during the three weeks that the test is administered.

This additional evaluation can be a point of discussion between you and your academic advisor as well as a key component of your work in SEMR 200, SEMR 300, and SEMR 400. Your final grade in SEMR400 will be influenced by your competency assessments and related ePortfolio artifacts throughout your coursework at Harrisburg University

**15. 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, punitive 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**.

**Tentative Class Schedule (Subject to Change)[2]**

| Week | Topics | Notes (tentative) |
|---|---|---|
| 1 | • Class Logistics and Course Introduction | Project Deliverable 1: Project Kickoff |
| 2 | • Finite Automata and Languages | |
| 3 | • Regular Expressions | |
| 4 | • Context-Free Languages | |
| 5 | • Pushdown Automata | |
| 6 | • Tokenization and Parsing | |
| 7 | • Midterm Exam | Project Deliverable 2: Progress Report |
| 8 | • Parsing with PDAs | |
| 9 | • Turing Machines | |
| 10 | • Decidability | |
| 11 | • Computational Complexity | |
| 12 | • NP-Completeness | |
| 13 | • Coping with NP-Completeness | |
| 14 | • Final Exam | Project Deliverable 3: Final Demo |

[2] The students will be consulted and must agree to any (should be minor though) modifications or deviations from the syllabus throughout the course of the semester.