Introduction to Cryptography

Bulletin Description

(Comp 790 Description) Permission of the instructor. This course has variable content and may be taken multiple times for credit.

General Course Info

Term: Fall 2021
Department: COMP
Course Number: 590/790
Section Number: 171

Time: MW, 9:05 – 10:20am
Location: SN0115
Website: http://www.cs.unc.edu/~saba/crypto_class

Instructor Info

Name: Saba Eskandarian
Office: Brooks 346
Email: saba@cs.unc.edu
Web: http://www.cs.unc.edu/~saba
Office Hours: See course website

Textbooks and Resources

We will primarily use Piazza for course announcements and answering questions. Please make sure to sign up! If you have any questions, comments, or suggestions regarding the course organization and policies, please feel free to reach out on Piazza or via email. Piazza allows for anonymous private posts if you prefer to give anonymous feedback.

Assignments and grading will be handled via Gradescope. See the class website for a link.

Optional textbooks: There is no required textbook. A Graduate Course in Applied Cryptography by Dan Boneh and Victor Shoup (free online) and Introduction to Modern Cryptography by Jonathan Katz and Yehuda Lindell are good resources for students looking to go deeper into the material covered in class.
Course Description

Cryptography is an indispensable tool for protecting information in computer systems. Our web browsers use it almost every time we connect to a website; it protects our private messages from prying eyes; it enables the modern world of online commerce; and it guards the freedoms of journalists, dissidents, and oppressed groups throughout the world.

At the same time, cryptography has deep connections to the theory of computation, number theory, algebra, and computational complexity theory. Major open questions in cryptography have immediate ramifications for whether P=NP, and cryptography research has given rise to several of the most beautiful ideas in computer science. These ideas (which we will cover) have been recognized by several Turing awards.

This course will introduce you to both sides of cryptography. Our main focus will be on the inner workings of cryptographic primitives and how to use them correctly. We will begin with standard cryptographic tools such as encryption, message authentication, key exchange, and digital signatures before moving on to more advanced topics like zero-knowledge and multiparty computation. See the course schedule page for a more detailed list of topics. Throughout the course we will also explore the techniques used in modern cryptography to reason about the security of cryptographic schemes.

Target Audience

This course is intended for anyone who wishes to understand and use the fundamental techniques of modern cryptography. It will also be of particular interest to students who have gained some exposure to cryptography through a security class or mathematics students who are interested to see some very practical uses of applied math. There will be both programming assignments and problem sets that involve writing proofs, so a solid foundation in basic computer science topics will be expected.

Prerequisites

Prerequisites for this course are COMP283, COMP 210, and COMP211 (or their equivalents).
Goals and Key Learning Objectives

By the end of this course, students should:
- Understand how crypto primitives used in practice work
- Know how to use cryptography to meet various security goals
- Be able to reason about the security of cryptographic schemes

Course Requirements

Classes will primarily be lectures, although a few group problem solving sessions may be included as well. In addition to attending lectures, students will solve problem sets that exercise various topics covered in class and complete programming assignments to develop practical experience using cryptography.

Key Dates

- Problem set 1 due Monday, September 20
- Programming assignment 1 due Monday, September 27
- Midterm exam in class on October 18
- Problem set 2 due Monday, October 25
- Programming assignment 2 due Monday, November 1
- Problem set 3 due Monday, November 15
- Problem set 4 due Monday, December 8

Grading Criteria

- Problem set average: 60%
- Programming assignment average: 20%
- Midterm exam: 20%
Course Policies

You must use LaTeX to write up your problem sets using the provided template. All assignments are due at 11:59pm on the listed day and must be submitted via Gradescope.

You get three “late days” in total during the semester. You may use a late day to submit a problem set after the deadline via Gradescope. You may only use late days in one-day increments (no partial late days). If you submit an assignment late after running out of late days, you will receive no credit for the submission. Please submit your assignments on time and save your late days for extraordinary situations.

Honor Code

You may discuss the problem sets with other students and you may work together to come up with solutions to the problems. If you do so, you must list the name of your collaborators on the first page of your submission. Each student must write up their problem set independently. Programming assignments can be completed independently or in pairs.

You may use the Boneh-Shoup textbook, or any other textbook of your choosing as a reference. If you use a result from a textbook in the course of solving a problem, please cite the textbook in your write-up. Please do not search the Internet for answers to problem set problems.

I expect all students to follow the guidelines of the UNC honor code. In particular, students are expected to refrain from “lying, cheating, or stealing” in the academic context. You can read more about the honor code at honor.unc.edu. Please see me if you are unsure about what may or may not violate the honor code in this class.

Course Schedule

See course website for schedule of topics

Attendance and Participation (updated)

Lectures will be simultaneously in person and on Zoom. Students who are not feeling well should not come to class and attend on Zoom if they are able. Students who prefer not to attend in person may join via Zoom too. Everyone is encouraged to participate in the class either in person or on Zoom, but recordings will be made available for those who can’t attend.
Acknowledgments

The structure of this course is inspired by Stanford's CS255 and CS355 courses.

Mask Use

This semester, while we are in the midst of a global pandemic, all enrolled students are required to wear a mask covering your mouth and nose at all times in our classroom. This requirement is to protect our educational community — your classmates and me — as we learn together. If you choose not to wear a mask, or wear it improperly, I will ask you to leave immediately, and I will submit a report to the Office of Student Conduct. At that point you will be disenrolled from this course for the protection of our educational community. Students who have an authorized accommodation from Accessibility Resources and Service have an exception. For additional information, see Carolina Together.

Grade Appeal Process

If you feel you have been awarded an incorrect grade, please discuss with me. If we cannot resolve the issue, you may talk to our departmental director of undergraduate studies or appeal the grade through a formal university process based on arithmetic/clerical error, arbitrariness, discrimination, harassment, or personal malice. To learn more, go to the Academic Advising Program website.

Accessibility Resources and Services

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in barriers to fully accessing University courses, programs and activities.

Accommodations are determined through the Office of Accessibility Resources and Service (ARS) for individuals with documented qualifying disabilities in accordance with applicable state and federal laws. See the ARS Website for contact information: https://ars.unc.edu or email ars@unc.edu.

Counseling and Psychological Services

CAPS is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: https://caps.unc.edu/ or visit their facilities on the third floor.
of the Campus Health Services building for a walk-in evaluation to learn more.

Title IX Resources

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Reports can be made online to the EOC at [https://eoc.unc.edu/report-an-incident/](https://eoc.unc.edu/report-an-incident/). Please contact the University’s Title IX Coordinator (Elizabeth Hall, interim – titleixcoordinator@unc.edu), Report and Response Coordinators in the Equal Opportunity and Compliance Office (reportandresponse@unc.edu), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (gvsc@unc.edu; confidential) to discuss your specific needs. Additional resources are available at safe.unc.edu.

Policy on Non-Discrimination

The University is committed to providing an inclusive and welcoming environment for all members of our community and to ensuring that educational and employment decisions are based on individuals’ abilities and qualifications. Consistent with this principle and applicable laws, the University’s Policy Statement on Non-Discrimination offers access to its educational programs and activities as well as employment terms and conditions without respect to race, color, gender, national origin, age, religion, creed, genetic information, disability, veteran’s status, sexual orientation, gender identity or gender expression. Such a policy ensures that only relevant factors are considered and that equitable and consistent standards of conduct and performance are applied.

If you are experiencing harassment or discrimination, you can seek assistance and file a report through the Report and Response Coordinators (see contact info at safe.unc.edu) or the Equal Opportunity and Compliance Office, or online to the EOC at [https://eoc.unc.edu/report-an-incident/](https://eoc.unc.edu/report-an-incident/).

Diversity Statement

I value the perspectives of individuals from all backgrounds reflecting the diversity of our students. I strive to make this classroom an inclusive space for all students. Please let me know if there is anything I can do to improve, I appreciate suggestions.

Syllabus Changes

I reserve the right to make changes to the syllabus, including project due dates and test dates. These changes will be announced as early as possible.