

CS 572
Network Security

Instructor: Dr. Zongming Fei
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Office hours: Monday and Wednesday, 2 to 3:30 PM

Course Description

This course introduces students to the state of the art of network security problems and solutions. Topics include security issues in computer networks, the Public Key Infrastructure ecosystem, key exchange protocols, and security mechanisms and protocols at the application, transport, network and data link layers. It will also discuss up-to-date development in the field of network security.

Prerequisites

CS 270 or EE 287 or consent of the instructor

Student Learning Outcomes

After completing this course, the student will be able to:

1. Explain why the Internet is insecure.
2. Name and define the standard security properties—confidentiality, authenticity, integrity, availability, non-repudiability (or accountability)—and give examples of bad things that can happen if they are violated.
3. Explain security threats at the network, transport, and application layers in the protocol stack.
4. Describe cryptographic approaches to securing (i) the Domain Name System, and (ii) application-to-application (program-to-program) communication, in detail.
5. Explain how firewalls work, and reason about how rulesets affect network reachability.
6. Describe one or more proposed architectural approaches—clean-slate or otherwise—to make the Internet more secure.

Required Materials

Required textbooks (one of them)

William Stallings, *Cryptography and Network Security: Principles and Practice* (7th Edition), Pearson, 2016. ISBN-10: 0134444280, ISBN-13: 978-0134444284.

Charlie Kaufman, Radia Perlman, Mike Speciner, *Network Security: Private Communication in a Public World* (2nd edition), Prentice Hall, 2002. ISBN-10: 0130460192, ISBN-13: 978-0130460196.

Description of Course Activities and Assignments

Course activities and assignments:

1. Lecture. There will be times (quite a few, actually), when I (or a guest lecturer) stand in front of the class and explain how things work. Sometimes I will use the projector, sometimes I will write on the blackboard/whiteboard. Your responsibility in these sessions is to show up, pay attention, and ask questions. I will make lecture notes/slides available via the course web page.
2. Study Outside of Class. Yes, this is required! Readings from outside sources will be assigned regularly. Most importantly, if you don't understand something, get help! It's fine for you to get help from your classmates.
3. Homework. The purpose of homework is to get you to do and think. If you don't do the assignments, you probably won't learn much.
4. Project. You will complete a project on a topic of your choice.
5. Exams. We will have one midterm exam and one final exam.

Course Assignments

A listing of required assignments for the grade are:

- 7 graded homework at 20 points each
- 1 project at 100 points
- 1 midterm exam at 50 points
- 1 final exam at 100 points

Summary Description of Course Assignments

Homework assignments will take different forms, including figuring out results using methods taught, explaining a security issue, experimenting with tools and reviewing a paper.

The midterm and final examinations will cover the student learning outcomes for this course.

For the project, the student will engage with a topic approved by the instructor and produce a substantial work product. The product may be a written paper, a nontrivial software artifact, or the results of an experiment. The topic requirements differ for undergraduate and graduate students:

- **Undergraduate students** must choose a topic on some aspect of network security not covered in class.
- **Graduate students** must choose a topic that is the subject of ongoing research (in network security) that is not covered in class.

Course Grading

Your performance in the course will be evaluated using the following methods, each of which will contribute the indicated amount to your final grade calculation:

- Class Participation. (10%)
- Homework. (25%)
- Individual Project. (25%)
- Midterm Examination (15%)
- Final Examination. (25%)

Grading scale for undergraduates:

90 – 100% = A
80 – 89% = B
70 – 79% = C
60 – 69% = D
Below 60% = E

Grading scale for graduate students (no D for Grad Students):

92 - 100% = A
84 – 91% = B
76 – 83% = C
Below 76%= E

Expectations for graduate students beyond the expectations for undergraduates

For the project, graduate students must choose a topic that is the subject of ongoing research (in network security) that is not covered in class. In contrast, undergraduate students must choose a topic on some aspect of network security not covered in class, but it does not have to be the subject of ongoing research. The grading of the projects submitted by graduate students will include the requirement of some level of creativity demonstrated by the projects.

Tentative Course Schedule

Week 1: How things work in the Internet;

Week 2: Why the network is insecure;

Homework 1 due

Week 3: Desired security properties; Security Policies; Management Considerations;

Week 4: Review of basic crypto-based algorithms

Homework 2 due

Week 5: The Public Key Infrastructure (PKI) ecosystem

Week 6: Key exchange protocols, Diffie-Helman

Homework 3 due

Week 7: Domain Name System Security Extensions (DNSSEC)

Homework 4 due
Week 8: Secure Socket Layer (SSL) and Transport Layer Security (TLS)
Midterm exam in Week 8 on Monday during the class time
Week 9: IPsec and Virtual Private Network (VPN)
Week 10: IEEE 802.1X
Homework 5 due
Week 11: Pattern-matching rules and Firewalls
Week 12: Intrusion Detection Systems
Homework 6 due
Week 13: The Content-Centric/Named Data approach
Homework 7 due
Week 14: Proposals for accountability in networks
Project due
Week 15: Security in Software-Defined Networking
Final Examination: Dec 15 Tuesday at 10:30am

Final Exam Information

Dec. 15, Tuesday at 10:30am, in the same classroom we have classes

Mid-term Grade

Mid-term grades for undergrads will be posted in myUK by the deadline established in the Academic Calendar (<http://www.uky.edu/registrar/calendar>).

Submission of Assignments

All homework assignment and the project will be submitted online using Canvas. No late submissions will be accepted unless it is due to an excused absence, in which case the student has one week for making up the missed work.

Attendance Policy

If you know you will miss a class, please inform the instructor of the details as soon as possible. Everyone gets two “free” unexcused absences; after that they begin to affect your grade. Every unexcused absence will result in one point being deducted from your final score, with the maximum of 10 points being deducted.

Excused Absences

Students need to notify the professor of absences prior to class when possible. *Senate Rules 5.2.4.2* defines the following as acceptable reasons for excused absences: (a) serious illness, (b) illness or death of family member, (c) University-related trips, (d) major religious holidays, and (e) other circumstances found to fit “reasonable cause for nonattendance” by the professor.

Students anticipating an absence for a major religious holiday are responsible for notifying the instructor in writing of anticipated absences due to their observance of such holidays no later than the last day in the semester to add a class. Two weeks prior to the absence is reasonable, but should not be given any later. Information regarding major religious

holidays may be obtained through the Ombud (859-257-3737, http://www.uky.edu/Ombud/ForStudents_ExcusedAbsences.php).

Students are expected to withdraw from the class if more than 20% of the classes scheduled for the semester are missed (excused) per University policy.

Per *Senate Rule 5.2.4.2*, students missing any graded work due to an excused absence are responsible: for informing the Instructor of Record about their excused absence within one week following the period of the excused absence (except where prior notification is required); and for making up the missed work. The professor must give the student an opportunity to make up the work and/or the exams missed due to an excused absence, and shall do so, if feasible, during the semester in which the absence occurred.

Verification of Absences

Students may be asked to verify their absences in order for them to be considered excused. *Senate Rule 5.2.4.2* states that faculty have the right to request “appropriate verification” when students claim an excused absence because of illness, or death in the family. Appropriate notification of absences due to University-related trips is required prior to the absence when feasible and in no case more than one week after the absence.

Academic Integrity

Per University policy, students shall not plagiarize, cheat, or falsify or misuse academic records. Students are expected to adhere to University policy on cheating and plagiarism in all courses. The minimum penalty for a first offense is a zero on the assignment on which the offense occurred. If the offense is considered severe or the student has other academic offenses on their record, more serious penalties, up to suspension from the University may be imposed.

Plagiarism and cheating are serious breaches of academic conduct. Each student is advised to become familiar with the various forms of academic dishonesty as explained in the Code of Student Rights and Responsibilities. Complete information can be found at the following website: <http://www.uky.edu/Ombud>. A plea of ignorance is not acceptable as a defense against the charge of academic dishonesty. It is important that you review this information as all ideas borrowed from others need to be properly credited.

Senate Rules 6.3.1 (see <http://www.uky.edu/Faculty/Senate/> for the current set of *Senate Rules*) states that all academic work, written or otherwise, submitted by students to their instructors or other academic supervisors, is expected to be the result of their own thought, research, or self-expression. In cases where students feel unsure about a question of plagiarism involving their work, they are obliged to consult their instructors on the matter before submission.

When students submit work purporting to be their own, but which in any way borrows ideas, organization, wording, or content from another source without appropriate acknowledgment of the fact, the students are guilty of plagiarism.

Plagiarism includes reproducing someone else's work (including, but not limited to a published article, a book, a website, computer code, or a paper from a friend) without clear attribution. Plagiarism also includes the practice of employing or allowing another person to alter or revise the work, which a student submits as his/her own, whoever that other person may be. Students may discuss assignments among themselves or with an instructor or tutor, but when the actual work is done, it must be done by the student, and the student alone.

When a student's assignment involves research in outside sources or information, the student must carefully acknowledge exactly what, where and how he/she has employed them. If the words of someone else are used, the student must put quotation marks around the passage in question and add an appropriate indication of its origin. Making simple changes while leaving the organization, content, and phraseology intact is plagiaristic. However, nothing in these Rules shall apply to those ideas, which are so generally and freely circulated as to be a part of the public domain.

Please note: Any assignment you turn in may be submitted to an electronic database to check for plagiarism.

Accommodations due to disability

If you have a documented disability that requires academic accommodations, please see me as soon as possible during scheduled office hours. In order to receive accommodations in this course, you must provide me with a Letter of Accommodation from the Disability Resource Center (DRC). The DRC coordinates campus disability services available to students with disabilities. It is located on the corner of Rose Street and Huguelet Drive in the Multidisciplinary Science Building, Suite 407. You can reach them via phone at (859) 257-2754 and via email at drc@uky.edu. Their web address is <http://www.uky.edu/DisabilityResourceCenter>.

Non-Discrimination Statement and Title IX Information

The University of Kentucky faculty are committed to supporting students and upholding the University's non-discrimination policy.

Discrimination is prohibited at UK. If you experience an incident of discrimination we encourage you to report it to Institutional Equity & Equal Opportunity (IEEO) Office, 13 Main Building, (859) 257-8927.

Acts of Sex- and Gender-Based Discrimination or Interpersonal Violence

If you experience an incident of sex- or gender-based discrimination or interpersonal violence, we encourage you to report it. While you may talk to a faculty member or TA/RA/GA, understand that as a "Responsible Employee" of the University these individuals MUST report any acts of violence (including verbal bullying and sexual harassment) to the University's Title IX Coordinator in the IEEO Office. If you would like to speak with someone who may be able to afford you confidentiality, the Violence Intervention and Prevention (VIP) program (Frazee Hall – Lower Level;

<http://www.uky.edu/StudentAffairs/VIPCenter/>), the Counseling Center (106 Frazee Hall, <http://www.uky.edu/StudentAffairs/Counseling/>), and the University Health Services (<http://ukhealthcare.uky.edu/uhs/student-health/>) are confidential resources on campus.