SYLLABUS

CPRE 538: Reverse Engineering and Security Testing

Fall 2024

Course Information

Time: Monday, Wednesday, and Friday from **11:00** a.m. to **11:50** a.m. CDT

Location: HOWE 1344 (In-person), https://iastate.webex.com/meet/celt1344Howe (Online)

Instructor: *Prof. Berk Gulmezoglu*, Office: 315 Durham Center, Email: bgulmez@iastate.edu

Office Hours: *Monday 1-2pm*

Disclaimer: I reserve the right to modify this syllabus to fix errors or to improve the quality of the course. I will communicate such changes via a Canvas announcement.

Course Format

This course offers an in-person section:

- You are expected to participate in the lecture and on Microsoft Teams for the discussions. You will be required to present one research paper and lead the discussion about the paper in the last two weeks of the semester.

Course Learning Objectives

By the end of the semester, students will:

- understand the fundamental concepts of reverse engineering,
- be able to analyze potential malware files,
- learn how to reverse engineer microarchitectural components as well as applying microarchitectural attacks.

Course Materials

The course will follow **Practical Malware Analysis: The Hands-on Guide to Dissecting Malicious Software** book. The online version of the book can be found through ISU library. Additional materials such as lecture notes, research papers and practices will be distributed along with the lectures.

Learning Activities and Assessments

Homework (6):

There will be six homework assignments throughout the semester that are due roughly every two weeks, although this may vary. Homework should be turned in on Canvas by the due date indicated in the Course Schedule below. The purpose of these assignments is to provide you with the opportunity to familiarize yourself with the reverse engineering tools and to practice several analysis techniques to understand the inner workings of third-party software and microarchitectural components. Moreover, you will use hardware reverse engineering techniques and tools to reverse engineer hardware components. You may submit multiple versions of your homework to Canvas, but only the last version prior to the due date will be graded.

Paper Presentation (1):

Once during the semester, you will make a presentation (about 20 minutes) on one of the assigned papers. You will also provide a list of discussion questions and related papers for further exploration on the topic. You will then co-lead a discussion involving the paper. This will count as half of your participation grade. You are required to submit your presentation on Canvas to get full points

Discussion Participation (10):

You are expected to engage with the course and discuss about malware analysis and microarchitecture security concepts. This interaction not only benefits your communication skills, but also helps other students learn. Therefore, you will be assessed on your participation. You must make at least ten substantive participation contributions throughout the course. This can be contributions to a lecture discussion, searching out the answer to an unanswered question from a lecture discussion, or asking a meaningful (i.e., not simply a clarifying question) question in a paper presentation.

Quizzes (11):

Students will have one quiz each week. The quizzes will be based on research papers (if any) and topics covered in the lectures. The 10 best quiz scores will be counted as your final quiz grade.

GRADING POLICIES

Points will be scaled in the following way (note that each category will have a separate meaning of points -- 100 points of homework is not equal to 100 points of participation):

Area	Percentage
Participation (Teams and in class)	10%
Bi-weekly Homework	45%
Weekly Quizzes	35%
Paper Presentation	10%
TOTAL	**100%**

Course grades will be assigned based on the following percentage intervals (there is no course-level curve):

Letter Grade	Total Grade
A	[93,100]
A-	[90,93)
B+	[87,90)
B	[83,87)
B-	[80,83)
C+	[77,80)
C	[73,77)
C-	[70,73)
D+	[67,70)
D	[63,67)

D-	[60,63)
F	[0,60)

Grade Appeal Process

If you become concerned about your instructor's class management, please communicate your concerns with your instructor. Concerns sometimes relate to grading methods, paper turnaround time, and course policies, as examples. Before you decide to appeal, check out ISU's academic appeal process.

Appealing Your Final Grade

If you feel that your final grade does not reflect the quality of the work you produced throughout the semester, please first discuss the issue with your instructor. If, after talking with your instructor, you still feel that your grade does not reflect the quality of your work, you can file a grade appeal. For a grade appeal, you will need to submit the following materials:

1. A memo explaining why your final grade does not reflect the quality of work you produced
2. All the work you completed during the semester (including major assignments and weekly assignments like discussions and workshops)
3. The course policies with grade breakdown

A panel of instructors will review your materials blindly and assign a grade based on the quality of the work. If the grade the panel assigns is higher than the grade you received, your grade will be changed accordingly. If, however, the grade the panel assigns is lower than the grade you received, your grade will remain the same.

Course Expectations

Timeliness and Late Submission

You should respect both my time as well as other students' time. You are expected to be ready to begin class prior to its scheduled start time. In return, I will end class precisely at its scheduled end time. You should also turn in all course work by the assigned deadlines. Every evaluation or assessment will be graded and returned within a week of its due date. When working in groups it is particularly important to turn in work on time because group mates are depending on that work to make progress on their work. Homework solutions will be posted after the due date. Therefore, no late homeworks are accepted. Portions of the term project may be submitted late, but the maximum score is reduced by 20% for each 24-hour period after the deadline.

Engagement

You are expected to watch lecture videos if you miss the class. You are also expected to read assigned papers and participate in interactive discussions with other students. This interaction not only benefits your communication skills, but also helps other students learn. I encourage you to attend synchronously when possible (via WebEx), but if this is not feasible, I expect participation via the WebEx Teams.

Time Commitment

Your weekly time commitment may vary depending on your interests, pre-requisite knowledge/skills, and time management ability. Your in-class time is only a fraction of the time I expect you to spend on the course – plan to put in about 10 hours a week outside of the course. However, as with any course, what you get out of the course is proportional to what you put in. Please start the Homework assignments earlier since they require

coding experience and data collection. The servers might be busy during the semester which potentially affects the side-channel information.

Course Calendar (Tentative)

A more detailed calendar with due dates and quizzes will be available on Canvas. Quizzes will be on Fridays! HW dues will be on Wednesdays!

Week-1: **-** General Intro to Software Reverse Engineering - Static/Dynamic Analysis (Ch 0,1)	**Practice:** No practice **Quiz:** No quiz
Week-2: - ISA, Disassembly (Ch 4)	**Practice:** Ghidra Components, data displays, disassembly **Quiz:** Quiz-1
Week-3: - Recognizing high-level constructs (Ch 6)	**Practice:** Ghidra disassembly, data types, data structure **Quiz:** Quiz-2 **HW-1 due**
Week-4: - Binary Program Analysis - Windows Internals - De-compilation Challenges	**Practice:** Ghidra cross-referencing and graphing and Ghidra decompilers **Quiz:** Quiz-3
Week-5: - Anti-disassembly techniques (Ch 15) - Dynamic analysis techniques (Ch 3)	**Practice:** Ghidra Dynamic Analysis **Quiz:** Quiz-4 **HW-2 due**
Week-6: - Debugging with OllyDbg	**Practice:** Ghidra advanced features **Quiz:** Quiz-5
Week-7: - Rootkits and Kernel Debugging	**Practice:** Options for Ghidra debugging **Quiz:** Quiz-6 **HW-3 due**
Week-8: - Anti-debugging and Rootkits (Ch 16,17, and 21)	**Practice:** Anti Debugging with Ghidra **Quiz:** Quiz-7
Week-9: - Hardware reverse Engineering Intro. - Front-end Intel Microarchitecture	**Practice:** TLB Reverse Engineering **Quiz:** Quiz-8 **HW-4 due**
Week-10: - Reverse Engineering Front-end - Back-end Intel Microarchitecture	**Practice:** PortSmash **Quiz:** Quiz-9
Week-11: - Transient Execution Features in Modern Processors	**Practice:** Spectre Attacks **Quiz:** Quiz-10 **HW-5 due**
Week-12: - Reverse engineering memory components (Cache)	**Practice:** Usage of timing analysis **Quiz:** Quiz-11
Week-13: - Microarchitectural Attack Detections	**Practice:** Usage of performance counters **HW-6 due**
Week-14: - Presentations	**Practice:**
Week-15: - Presentations	**Practice:**

ISU Syllabus Statements

Free Expression

Iowa State University supports and upholds the First Amendment protection of [freedom of speech](#) and the principle of [academic freedom](#) in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.

Questions about the required Statement?

Review the following resources:

- [New required syllabus statement on free expression, Nov. 11, 2020 page](#)
- [Free Expression and Academic Freedom Syllabus Statement Frequently Asked Questions page (SVPP)](#)
- [Iowa State University's Free Speech website](#)

Academic Dishonesty

The class will follow Iowa State University's policy on academic dishonesty. Any usage of AI-based tools is prohibited unless explicitly stated by the question that you can use AI tools. If you are not sure about the usage of AI for a question, please ask it to your TA. Anyone suspected of academic dishonesty will be reported to the [Dean of Students Office](#).

Accessibility Statement

Iowa State University is committed to assuring that all educational activities are free from discrimination and harassment based on disability status. Students requesting accommodations for a documented disability are required to work directly with staff in Student Accessibility Services (SAS) to establish eligibility and learn about related processes before accommodations will be identified. After eligibility is established, SAS staff will create and issue a Notification Letter for each course listing approved reasonable accommodations. This document will be made available to the student and instructor either electronically or in hard-copy every semester. Students and instructors are encouraged to review contents of the Notification Letters as early in the semester as possible to identify a specific, timely plan to deliver/receive the indicated accommodations. Reasonable accommodations are not retroactive in nature and are not intended to be an unfair advantage. Additional information or assistance is available online at www.sas.dso.iastate.edu, by contacting SAS staff by email at accessibility@iastate.edu, or by calling 515-294-7220. Student Accessibility Services is a unit in the Dean of Students Office located at 1076 Student Services Building.

AY2021-22 recommended statements:

- **Face Masks Encouraged**: All students, faculty, staff, and visitors to campus are encouraged to wear face masks in all indoor spaces when around others. Unvaccinated individuals are encouraged to wear a face mask anywhere they are around others, and to practice physical distancing when possible https://web.iastate.edu/safety/updates/covid19.

- **Vaccinations Encouraged**: All students are encouraged to receive a vaccination against COVID-19. Multiple locations are available on campus for free, convenient vaccination. Further information is available at: https://web.iastate.edu/safety/updates/covid19/vaccinations Vaccinations may also be obtained from health care providers and pharmacies.

- **Physical Distancing Encouraged for Unvaccinated Individuals:** Classrooms and other campus spaces are operating at normal capacities, and physical distancing by faculty, staff, students, and visitors to campus is not required. However, unvaccinated individuals are encouraged to continue to physically distance themselves from others when possible.

Discrimination and Harassment

Iowa State University does not discriminate on the basis of race, color, age, ethnicity, religion, national origin, pregnancy, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a U.S. Veteran. Inquiries regarding non-discrimination policies may be directed to Office of Equal Opportunity, 3410 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011, Tel. 515-294-7612, Hotline 515-294-1222, email eooffice@iastate.edu

Prep Week

This class follows the Iowa State University Prep Week policy as noted in section 10.6.4 of the Faculty Handbook.

Religious Accommodation

Iowa State University welcomes diversity of religious beliefs and practices, recognizing the contributions differing experiences and viewpoints can bring to the community. There may be times when an academic requirement conflicts with religious observances and practices. If that happens, students may request the reasonable accommodation for religious practices. In all cases, you must put your request in writing. The instructor will review the situation in an effort to provide a reasonable accommodation when possible to do so without fundamentally altering a course. For students, you should first discuss the conflict and your requested accommodation with your professor at the earliest possible time. You or your instructor may also seek assistance from the Dean of Students Office at 515-294-1020 or the Office of Equal Opportunity at 515-294-7612.

Contact Information for Academic Issues

If you are experiencing, or have experienced, a problem with any of the above statements, email academicissues@iastate.edu

(Important note to faculty: The email address for contact information is monitored and answered through the Office of the Senior Vice President and Provost)