Logical Foundations

Bulletin Description

This course is an upper-level undergraduate and graduate course about the use of mathematical proof techniques to verify the correctness of computer systems. The course will cover foundational concepts in logic, the theory of programming, and program verification. Students will learn about computer assisted theorem proving and will learn to use Coq, a proof assistant. Classes will be organized around problem sets and in-person lectures. In addition, students will work on a semester-long project developing a proof of correctness of a program related to their research. COMP 790 satisfies the theory and formal thinking breadth requirement for graduate students.

General Course Information

Term:	Spring 2022
Department:	COMP
Course Number:	590/790
Section Number:	132
Time:	MW 11–12:15
Location:	SN 011
Website:	https://cs.unc.edu/~csturton/courses/logicalfoundations/

Instructor Information

Name:	Cynthia Sturton
Office:	FB 354
Email:	csturton@cs.unc.edu
Website:	http://www.cs.unc.edu/~csturton
Office Hours:	TBD

Textbook and Resources

The required textbooks are free and available online:
Software Foundations Volume 1: Logical Foundations
Software Foundations Volume 2: Programming Language Foundations

Course Description

In this course we delve into the theory of programming and program verification. Students will learn the foundational concepts in logic, learn about computer assisted theorem proving, and will learn to use Coq, a proof assistant. Classes will be organized around in-class lectures and

problem sets. In addition, students will work on a semester-long project developing a proof of correctness of a small program of their choosing.
The class is intended for undergraduate students who have taken COMP 301 and computer science graduate students. The class satisfies the theory and formal thinking breadth requirement for graduate students.
Topics covered include: enumerated types; inductively defined types, data structures, and propositions; proof by induction; polymorphism and higher-order functions; relations; Hoare Logic; and the application of the Coq proof assistant to prove program correctness.

Goals and Learning Objectives

By the end of this class, students will be able to

- understand the basics of mathematical theorem proving
- use the Coq theorem prover to write machine-checked proofs
- specify and prove correctness of an algorithm or model relevant to their interests or research

Target Audience

The class is designed for upper-level undergraduate and graduate students who are interested in the theory of programming, program verification, and logic.

Prerequisites

This class is open to undergraduate students who have taken COMP 301 and to all CS graduate students. Students should have familiarity with propositional logic and a basic understanding of proof by induction. Undergraduate CS students and graduate students outside the CS department who wish to enroll in the course should attend the first week of class and speak to the instructor to obtain permission.

Course Requirements

Classes will be organized around a combination of in-person lecture and exercises using the Coq proof assistant. In addition, students will work in groups of 2 to develop a proof of correctness for a computer system or program of their choosing. At the end of the semester, each group will submit their proof, a conference-style paper, and deliver a short (10–15 min) presentation describing their work.

Key Dates

Project proposals:	2/14/22
Progress report:	3/9/22
Complete proof:	4/20/22

Final report: 4/27/22
Final presentations: 5/6/22

Grading Criteria

Project: 35%
Assignments: 50%
Participation: 15%

Grads (790)			**Undergrads (590)**	
Grade	**Range**		**Grade**	**Range**
H+	[96 ⅔, 100]		A	[95, 100]
H	[90 ⅓, 96 ⅔)		A-	[90, 95)
H-	[90, 90 ⅓)		B+	[86 ⅔, 90)
P+	[86 ⅔, 90)		B	[83 ⅓, 86 ⅔)
P	[83 ⅓, 86 ⅔)		B-	[80, 83 ⅓)
P-	[80, 83 ⅓)		C+	[76 ⅔, 80)
L+	[76 ⅔, 80)		C	[73 ⅓, 76 ⅔)
L	[73 1/3, 76 ⅔)		C-	[70, 73 ⅓)
L-	[65, 73 ⅓)		D+	[65, 70)
F	[0, 65)		D	[60, 65)
			F	[0, 60)

Course Policies

Classes are centered around lecture and exercises; attendance is necessary in order to contribute.

Spring 2022 Course Delivery
As long as it is possible to do so safely, we will be meeting in person this semester. I understand the ongoing COVID-19 pandemic may require changes to this plan and will be monitoring the situation closely. If I need to change the format of the course temporarily due to outbreaks of illness, I will announce this via the course campuswire site.

Accessibility Resources and Service (ARS)

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. (source: https://ars.unc.edu/faculty-staff/syllabus-statement)

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. (source: Student Safety and Wellness Proposal for EPC, Sep 2018)

Honor Code

The final project must be original research. Students will work in groups of 2 or 3 for the final project, and submit one artifact, one written report, and one final presentation per group.

All students are expected 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. If you are unsure about which actions violate that honor code, please see me or consult honor.unc.edu. (source: Department of Asian Studies)

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. Please contact the Director of Title IX Compliance (Adrienne Allison – Adrienne.allison@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. (source: https://curricula.unc.edu/curriculum-proposals/cim/syllabus/)

Course Schedule

The course schedule will be posted on the course website.

Disclaimer

The professor reserves the right to make changes to the syllabus, including project due dates. These changes will be announced as early as possible.