

Syllabus

Fall 2020 COMP 311.001: MACHINE ORGANIZATION

Course Information: Term: Fall 2020

Department: COMP - Computer Science

Course Number: 311

Section Number: 001

Time: MW 8:45am-10:00am, F 9:15-10:20am

Location: Online, with Zoom <https://unc.zoom.us/j/99550578008>

Class website: on Sakai.unc.edu as

<https://sakai.unc.edu/portal/site/325bf7ab-2b78-4686-ab88-3dc4957f82da>

Piazza: piazza.com/unc/fall2020/comp311

Prerequisite: COMP 211 with a grade C or better.

Instructor:

Name: Henry Fuchs

Office: FB 216 (Brooks), expect to be online the entire semester

Email: fuchs@cs.unc.edu

Phone: 919.590.6211

Website: <http://henryfuchs.web.unc.edu/>

Office hours: see calendar and Zoom links [here](#) or from the class Sakai website.

TAs/uLAs:

Andrew Freeman • acfreeman@cs.unc.edu (Grad TA)

Shai Caspin • shai@unc.edu (ULA)

Matthew Gregoire mattyg@ad.unc.edu (ULA)

Yunzhou Liu • yunzhou@live.unc.edu (ULA)

Office hours: see calendar and Zoom links [here](#) or from the class Sakai website.

Textbook:

Patterson and Hennessy, Computer Organization and Design, 5th ed. (Oct 2013), ISBN 9780124077263, Morgan Kaufmann.

The 5th edition can be purchased or rented very cheaply, and can also be found online and in the UNC library online archives [here](#). Older versions can also be used, but readings will be given following the 5th edition sections and pages.

Resources:

To access the class zoom meetings (lecture, recitations, and office hours), you must be signed into zoom via your UNC email accounts. Each student must have full use of a personal laptop computer. Any CCI-compliant computer will be fine; acceptable configurations include: Mac, Windows or Linux operating systems, Chrome or Safari web browsers, and Java SE 9 or newer. Some lab assignments will be submitted by logging in to a designated server requiring a [UNC VPN](#), and homework, quizzes and exams will be submitted via Sakai. Other software ([DIGITAL](#) simulator, and [MARS](#) assembler and simulator) will be provided or downloadable for free.

The course website on Sakai will be the primary means for distributing information including lecture notes, homework and lab assignments, assessments, reporting scores, calendar and announcements. You need to monitor Sakai regularly. We will use the online bulletin board Piazza for questions, so you will need to sign up for [Piazza](#).

Each student is responsible for a set of hardware supplies listed on Sakai>Resources to be able to perform many of the labs. The components can be ordered as a kit from Jameco (link on Sakai) or purchased individually from other sources.

Recitations:

Attendance at Friday recitations is mandatory . All quizzes and the midterm will be administered during this time. There will be 4 concurrent recitation sections, divided based on last name. The recitation assignments and zoom links will be available on the class Sakai website.

Course Overview: This course is an introduction to computer organization. Topics include digital logic, basic circuit components, data and instruction representation, computer architecture and implementation, and assembly language programming.

Target Audience: This course is an introduction to computer design suitable for undergraduate computer science students, and graduate students from other fields, who already have a basic understanding of systems programming (COMP 211).

Goals and Key Learning Objectives: A key goal of this course is to demystify the inner workings of a computer. Students will learn (i) how to program computer hardware at a lower level (in assembly language based on prerequisite knowledge of C); (ii) how computer hardware is designed using transistors and logic gates; and (iii) the relationship between hardware and software. This course will be beneficial both to students who want to pursue a career or further studies in the field of computer architecture and design, and to students who simply want a basic understanding of computer hardware so they can write better software.

Course Content (and approximate time allocation):

- Introduction (1 week)
- Combinational Systems (1 week)
 - Combinational gates and circuits
 - Truth Tables and Boolean Synthesis
 - Addition and Subtraction in an ALU (Arithmetic Logic Unit)
 - ALU Control
- Sequential Systems (1 week)
 - Clock and timing
 - Latches
 - Flip Flops
 - Registers
- Building an 8-bit computer (2 weeks)
 - Datapath and Control Flow
 - Instructions
 - Branching and Conditional Logic
 - Overflow
 - SAP - Simple As Possible computer
- Performance (1 week)
 - Latency and Throughput
 - Evaluating performance
 - Improving performance
- Fabrication (1 week)
 - Digital abstraction
 - Number representation choices
 - Memory and Transistor fabrication
 - Gate fabrication
- Building a computer (1 week)
 - Bigger instruction sets
 - Increasing memory sizes
 - Instruction compilation
 - Performance
- Instruction Sets (2 weeks)
 - Programming with the MIPS ISA (Instruction Set Architecture)
 - Looping and Branching Logic
 - Compiling MIPS instructions
 - Managing Stack and Heap
- MIPS Computer (1 week)
 - Interrupts
 - Input/output

- o Program tracing
- o Datapath and control
- o Performance Advancements over SAP-16
- Increasing Memory Performance (1 week)
 - o RAM/ROM Organization
 - o Memory Hierarchy
 - o Caches and Virtual Memory
- Increasing Computational Performance (1 week)
 - o Pipeline Basics
 - o Two-, Four-, and Five-Stage Processor Pipelines
 - o Structural, Data, and Branch Hazards
 - o Multicore and Parallel Programming
 - o GPUs
 - o Performance Impact

Exams: There will be one in-class mid-term exam and a final exam, plus some quizzes, dates to be announced on the class website. These will be administered using Sakai.

Grading: Problem Sets: (~4): 15%
 Labs: (~6) 25%
 Quizzes (~6): 15%
 Midterm Exam (1): 20%
 Final Exam (1): 25%

Grading scale: The following grading scale will be used to determine letter grades. Individual assignments will not be curved. Final grades may be adjusted at the discretion of the instructor.

A : 93 – 100	C+ : 77 – 79.99
A– : 90 – 92.99	C : 73 – 76.99
B+ : 87 – 89.99	C– : 70 – 72.99
B : 83 – 86.99	D+ : 65 – 69.99
B– : 80 – 82.99	D : 60 – 64.99
	F : < 60

Attendance: Attendance in online lectures is highly encouraged, and mandatory for recitations. Lecture recordings will not be published online. In addition, we encourage turning your camera on and actively participating by asking questions aloud, to the ULAs, and in chat. Those who attend more than 80% of lectures and turn their cameras on will receive 2 points extra credit on their final grade.

Late policy: Late submissions of lab assignments will be accepted up to one week after the due date for 10% credit penalty per day late, after 7 days assignments will be accepted and graded, but with no feedback for up to 30% of original credit. Homework solutions will be posted shortly after the assignment due date, therefore late submissions will not be accepted.

We realize that circumstances may cause students to miss deadlines or quizzes (illness, job interviews, computer crashes, etc.). To account for this, **the lowest lab score will be dropped, the lowest homework score will be dropped, and the lowest quiz score will be dropped**. This policy provides a consistent and fair means of adjudicating missed submissions, and provides grace in unforeseen circumstances (such as sickness, travel, death in the family, etc...). Regardless of the cause for a low score (either missing the submission or performing poorly), only the one lowest score will be dropped. To be clear, if you have a 0% grade because you missed a quiz due to illness, and a 35% grade on another quiz, only the 0% score will be dropped at the end of the semester.

If the above generous policy is insufficient for your needs, we will need serious documentation of your special situation and probably approval from higher department leadership. Please be proactive about

your unusual situation so we can all plan for it -- for example, your sibling is getting married and you'll be out for a week.

Incompletes: Incompletes and CVs will be given only in dire emergencies such as illness or a family emergency. Documentation will be required.

Honor Code: See <http://honor.unc.edu>
The Honor Code is in effect in this class, as in all others at the University. The Honor System's "Honor in the Syllabus" page includes the following suggested "affirmation of the Honor Code":
The University of North Carolina at Chapel Hill has had a student-administered honor system and judicial system for over 100 years. The system is the responsibility of students and is regulated and governed by them, but faculty share the responsibility. If you have questions about your responsibility under the honor code, please bring them to your instructor or consult with the office of the Dean of Students or the Instrument of Student Judicial Governance. This document, adopted by the Chancellor, the Faculty Council, and the Student Congress, contains all policies and procedures pertaining to the student honor system. Your full participation and observance of the honor code is expected.

We are very serious about the honor code. While it's easy to cheat in this course, it's also very easy for us to detect plagiarism. So don't do it! You are encouraged to work together for better understanding of the course material and assignment requirements, but **do the actual coding by yourself**. Too much reliance on others can be disastrous at exam time.

You are free to use any code that was presented in class, in recitation or other help sessions, with attribution (in the comments). You may NOT use code that you found on the web, or material from previous offerings of this course.

Due to the class being offered fully online, quizzes and exams will be administered on Sakai. We will require you to follow the honor code guidelines as specified for each assignment. Details on the administration of quizzes and exams will be communicated via announcements on the Sakai course page.

Community Standards in Our Course and Mask Use: This fall 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. An exemption to the mask wearing community standard will not typically be considered to be a reasonable accommodation. Individuals with a disability or health condition that prevents them from safely wearing a face mask must seek alternative accommodations through the Accessibility Resources and Service. For additional information, see Carolina Together.

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.

Acknowledgement: Most of this material has been adapted from syllabi of prior versions of this course, as taught by Professors Montek Singh, Anselmo Lastra, Gary Bishop, and Henry Fuchs.

This syllabus is subject to change at the discretion of the instructor. For any questions, please contact the instructor or TAs.