

# CSCE 231: Computer Systems Engineering

Fall 2020

## Schedule

All times are U.S. Central Time (UTC-5 until November 1; UTC-6 after November 1)

### Lecture

- Section 150: Monday, Wednesday, Friday via prerecorded videos

### Recitation

- Section 153: Monday 3:30pm-4:20pm in Zoom
- Section 151: Tuesday 3:30pm-4:20pm in Zoom
- Section 152: Wednesday 8:30am-9:20am in Zoom

### Laboratory

- Section 165: Monday 4:30pm-6:20pm in Avery 021 & Zoom
- Section 161: Tuesday 4:30pm-6:20pm in Avery 021 & Zoom
- Section 162: Tuesday 6:30pm-8:20pm in Avery 021 & Zoom
- Section 163: Wednesday 9:30am-11:20am in Avery 021 & Zoom
- Section 164: Wednesday 1:30pm-3:20pm in Avery 021 & Zoom

*The Zoom link for recitation & laboratory will be available on Canvas.*

## Instructor

Dr. Christopher Bohn                    bohn@unl.edu  
Office Hours: TR 9:30-11:00am        Avery 262  
Zoom office hours link: [https://go.unl.edu/bohn\\_office\\_hours](https://go.unl.edu/bohn_office_hours)

## TAs

Name	Office Hours	email
Aaron Johnson	M,W 11:30am-12:30pm	aaronjohnson14325@gmail.com
Brennan Rhoadarmer	M,F 9:30-11:00am	rhoodarmerb@gmail.com
Katie Gerot	M,T 9:00-10:00am	katie.gerot@huskers.unl.edu
Christine Discenza	R 12:30-2:30pm	cdisenza3@gmail.com
Thomas Hillebrandt	M,F 1:30-2:30pm T,R 10:00-11:00am	thomas.hillebrandt@huskers.unl.edu
Adrian Pilkington	M 7:00-9:00pm	apilkington@huskers.unl.edu

TA office hours are in the CSE Virtual Student Resource Center (vSRC).

# Catalog Description

Computer Systems Engineering (4 cr) Lec 3, rct 1, lab 2. Introduction to organization, structure, and applications of computer systems. Boolean Logic, Digital Arithmetic, Processor Organization, C Programming, Machine Language Programming, Input/Output, Memory Organization and Management, Building Embedded System Application.

## Prerequisites

Grade of “P” or “C” or better in CSCE 235, CSCE 235H, or RAIK 184H.

## Prerequisites by Topic

- *Mastery of* mathematical problem solving skills, mathematical maturity and competence to the level of introductory calculus
- *Familiarity with* programming, logarithms, integer and floating point numbers
- *Exposure to* recursion, operating systems services

## Course Objectives

- *Mastery of* Boolean algebra, logic equations, binary numbers (including negatives), fixed-point binary arithmetic, hexadecimal notation, exponential numbers
- *Mastery of* C programming, accessing I/O devices, processor organization, stacks, subroutines, instruction set architecture (with hands-on experience in embedded system design and implementation)
- *Familiarity with* logic gates and diagrams, floating point arithmetic, memory devices and hierarchies, micro-operations & micro- architectures
- *Familiarity with* assembler language principles, flow of control, assemblers, linkers, loaders, the syntax & semantics of short assembler programs
- *Familiarity with* memory errors such as buffer overflows and segmentation faults, security vulnerabilities

## Course Goals

How does a modern digital computer interpret programs written in a high-level programming language into the streams of electronic signals that actually do the thinking, the arithmetic, the keeping track of data, the sequencing of actions, and the input/output? What is the hardware-software interface and how can we use it to build modern computer systems and develop software? What system design considerations go into defining and designing it? In this course you will gain an understanding of the interface by first writing programs in a low-level assembly language that is close to the machine language,

developing the logic design of basic processor components, and then designing and implementing an embedded system. In the process you will gain practical experience with computer-aided design tools and C programming environments. The course comprises of lectures, recitation, and labs. The recitation sessions are used to prepare students to tackle the implementation and experimentation aspects of concepts discussed during lectures. The labs provide time for students to implement and experiment with these topics.

## Topics Covered

1. *System Level Organization*: CPU, memory systems (main memory, cache, virtual memory), storage technologies, I/O devices & processes
2. *Arithmetic and Logic Level*
  - (a) Boolean algebra, truth tables, logic equations, logic gates, combinatorial logic, sequential logic & memory devices, clocks, waveform diagrams
  - (b) Signed & unsigned binary numbers, floating-point numbers, BCD, hexadecimal, ASCII
  - (c) Signed & unsigned fixed-point arithmetic, floating-point arithmetic, ALU structures
3. *Micro-Architecture Level*: data paths & components, micro- operations, memory interfacing, the fetch/execute cycle
4. *Instruction Set Architecture Level*: instruction types & formats, opcodes, operands, immediate values, addressing modes, flow of control, branching & procedure calls
5. *Assembler Language level*: syntax, directives vs. instructions, assemblers, linkers, loaders, semantics of simple programs, stack management, procedure calls
6. *High-Level Programming Level*: C programming syntax, pointer arithmetic, I/O access, polling & interrupt handling, dynamic memory management, memory errors, security vulnerabilities

## Lecture, Recitation, and Laboratory

While the lecture will occasionally address practical matters, the principal purpose of the lectures is to provide you with a theoretical understanding of computer systems engineering. Through the individual labs, the group lab, and the group project, you will learn to apply this theory to practice. The recitation will help you transition from the theory of the lectures to the practice of the labs.

It is a common misunderstanding that the purpose of this course is to program in C. That is not the case. A course such as this requires working with computer systems much closer to the hardware level than most software developers typically do. Few high-level languages afford access to the underlying computer system, and of those that do, C is by far the most commonly- used.

# Grading

Your grade will be calculated based on your performance in the following areas:

- *Homework* (20%) Homework will help cement the concepts from the lecture and the textbook. Doing so will pay off in the other components of the course grade. Because group study is an effective learning technique, I encourage you to work with your peers to discuss the homework, but **be sure to write your own solutions and indicate whom you worked with.**
- *Labs* (30%) The labs will provide hands-on practice to provide better understanding of what you've learned in the lectures. Some labs will be programmed in C; others entail assembly programming.
- *Midterm Exams* (30%) We will have two midterm exams, that you will take during lab time. They are scheduled for **September 21-23** and **October 26-28**; if there are changes, I'll announce them at least a week in advance. *Unless I explicitly specify otherwise, the exams will be closed book/closed note/closed neighbor/closed internet; and programmable calculators, laptops, tablets, and smartphones will be disallowed.* You may have one  $8\frac{1}{2}'' \times 11''$  sheet of notes, double-sided, printed or hand-written. Alternate exams will be available for students who cannot attend lab in-person.
- *Final Exam* (20%) This will be a comprehensive exam, scheduled for **Sunday, November 25 at 3:30-5:30pm**. As with the midterm exams, unless I explicitly specify otherwise, the exams will be closed book/closed note/ closed neighbor/ closed internet.
- Final grades will be assigned based on the traditional cutoff percentages.

Grade	A+	A	A-	B+	B	B-	C+	C	C-	D	F
Score	97	93	90	87	83	80	77	73	67	60	<60

- *Rounding of final grades* I am not in the habit of *giving* grades, but I am sympathetic to students who put in effort. In lieu of rounding, after calculating each student's score and adding extra credit points, I will make one final adjustment to scores near a letter-grade cutoff:

$$adjustment = \begin{cases} 0.50 & \text{if all assignments completed} \\ 0.015 \times \text{number.of.assignments.completed} & \text{otherwise} \end{cases}$$

# Textbooks

- *Programming at the Hardware-Software Interface*, 1st ed., Christopher A. Bohn
- Other useful references available in the “Pages” section of the course’s Canvas site, including *The C Programming Language*, 2nd ed., Brian W. Kernigan & Dennis M. Ritchie (“K&R”)

# Notional Sequence

Topics		Chapter
Week 1: August 17-21		
lecture	Intro, Prerequisite review, Digital data	1, 2
lab	Lab 0 (Simple C refresher, environment setup)	
Week 2: August 24-28		
lecture	Digital data, Integer Arithmetic	2, 3
lab	Lab 1 (Advanced C refresher)	
Week 3: August 31 - September 4		
lecture	Integer, Floating Point Arithmetic	3, 4
lab	Lab 2 (Integer Lab)	
Week 4: September 7-11		
lecture	Floating Point Arithmetic	4
lab	Lab 3 (Float Lab)	
Week 5: September 14-18		
lecture	Simple Assembly Language	5
lab	Lab 3, continued	
Week 6: September 21-15		
lecture	Simple & Structured Assembly Language	5, 6
lab	Exam 1 (weeks 1-5)	
Week 7: September 28 - October 2		
lecture	Structured Assembly Language	6
lab	Lab 4 ("Bomb" Lab)	
Week 8: October 5-9		
lecture	Assembly Language, Buffer Overflow	6, first half of ch11
lab	Lab 4, continued	
Week 9: October 12-16		
lecture	Concurrency, Processor Design	7, first half of ch8
lab	Lab 5 ("Attack" Lab)	
Week 10: October 19-23		
lecture	Simple Processor Design	first half of ch8
lab	Lab 5, continued	
Week 11: October 26-30		
lecture	Exceptional Control Flow, System I/O	9
lab	Exam 2 (weeks 6-10)	
Week 12: November 2-6		
lecture	Advanced Processor Design	second half of ch8
lab	Lab 6 (TBD)	
Week 13: November 9-13		
lecture	Advanced Processor Design, Memory	10, second half of ch8
lab	Lab 6, continued	
Weeks 14-15: November 16-20		
lecture	Memory, Tying it all together	10, 12, second half of ch11
lab	no lab currently scheduled	
Final Exam: Sunday, November 25, 3:30-5:30pm		

# Policies and Resources

- *Attendance:* Lecture this semester will be prerecorded and will be available through VidGrid; you may view them at any time. I plan to release a week's worth of lectures prior to the start of that week. We will cover some material in class that is not covered in the text; your assignments and test questions may be based on that material. In particular, many of the details necessary to complete assignments will be presented in class. In the interest of maximizing knowledge retention, do not binge-watch the recordings. It is to your benefit to watch the recordings during their nominal week.
- *Class Preparation and Participation:* I expect you to be prepared for class, participate in discussions, and ask and answer questions.
- *Assignments:* All work must be completed when due, and all quizzes and exams must be taken when given. **No make-up quizzes or exams will be given, and with rare exception no late homework or labs will be accepted.** If you have a valid excuse (e.g., illness or injury of yourself or your dependent, an academic conference, a job interview, military obligation, jury duty, bereavement, religious observances, participation in university-sponsored intercollegiate athletic events, etc.), the score for a missed quiz or exam score will be replaced by the average of the remaining quizzes/exams. Similarly, if you have a valid excuse then at my option you will either be given an extension on a homework or lab assignment or will have the missed score replaced by the average of the remaining assignments in the same category.
  - If you wish to challenge the grade you received on an assignment, you must demonstrate that the answer you provided is correct; *i.e.*, that your grade is erroneous. We will not adjust your grade if your answer is too illegible for us to read. You will have two class-days in which to do so. We will not adjust grades for an assignment after two days past the day on which it was returned to you.
  - I will, at a minimum, honor the guidance for excused absences in the UNL Faculty Senate's Class Attendance Policy. See <https://www.unl.edu/facultysenate/classattendancepolicy%20%20April%203%2C%202018.pdf>
    - \* Notify me of planned absences in advance, and preferably early. I will not excuse missed assignments due to planned absences if you notify me after-the-fact.
    - \* Notify me of unplanned absences when you are able. In general, I will not require proof of the excuse; however, I will require proof of the excuse for missed exams, and I may require proof of the excuse if absences are extended or common.
    - \* If missed assignments due to excused absences become frequent enough that I cannot gauge how well a student has met the course objectives, then at my discretion I may award an "Incomplete" for the course and require the student to complete the assignments before receiving a letter grade.
  - We will provide information regarding the exams at a future date.
- *Services for Students with Disabilities:* The University strives to make all learning experiences as accessible as possible. If you anticipate or experience barriers based on

your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can discuss options privately. To establish reasonable accommodations, I may request that you register with Services for Students with Disabilities (SSD). If you are eligible for services and register with their office, make arrangements with me as soon as possible to discuss your accommodations so they can be implemented in a timely manner. SSD contact information: 232 Canfield Admin. Bldg.; 402- 472-3787.

- *Counseling and Psychological Services* UNL offers a variety of options to students to aid them in dealing with stress and adversity. Counseling and Psychological Services (CAPS, <https://caps.unl.edu/>) is a multidisciplinary team of psychologists and counselors that works collaboratively with Nebraska students to help them explore their feelings and thoughts and learn helpful ways to improve their mental, psychological and emotional well-being when issues arise. CAPS can be reached by calling 402-472-7450. Big Red Resilience & Well- Being (<https://resilience.unl.edu/big-red-resilience-well-being>) provides fun events, innovative education, and dynamic services to help students understand emotions, manage stress, build strength, connect with others, develop grit and navigate transitions.
- *Diversity and Inclusion* The University of Nebraska-Lincoln does not discriminate on the basis of race, ethnicity, color, national origin, sex (including pregnancy), religion, age, disability, sexual orientation, gender identity, genetic information, veteran status, marital status, and/ or political affiliation.
- *Student Resource Center*: The CSE Department has established a Virtual Student Resource Center which you can access through Canvas. See <https://canvas.unl.edu/courses/95368>.
- *Check Your Email* The CSE Department's policy is that all students in CSE courses should regularly check their email so they don't miss important announcements.
  - We will make announcements through Piazza; make sure that Piazza is configured to forward these announcements to your preferred the email address.
  - When email is appropriate, we will contact you through the email in Canvas; make sure that Canvas is has your preferred the email address.
  - If you aren't already doing so, I strongly encourage you to check your huskers.unl.edu email daily. The university has indicated that any announcements it makes will be to your huskers.unl.edu email.
- *Departmental Contact Form*: The CSE Department has an Anonymous Online Contact Form that you may use to voice your concerns about any problems in the course or department if you do not wish to be identified. See <http://cse.unl.edu/contact-form>.
- *Academic Integrity Policy*: Academic honesty is essential to the existence and integrity of an academic institution. The responsibility for maintaining that integrity is shared by all members of the academic community. The University's Student Code of Conduct addresses academic dishonesty. Students who commit acts of academic dishonesty are subject to disciplinary action and are granted due process and the

right to appeal any decision. See <https://stuafs.unl.edu/DeanofStudents/Student%20Code%20of%20Conduct%20May%20Rev%202014%20a.pdf>.

All homework assignments, exams, etc. must be your own work. The Computer Science and Engineering department has an Academic Integrity Policy. All students enrolled in any CSE course are bound by this policy. You are expected to read, understand, and follow this policy. Violations will be dealt with on a case by case basis and may result in a failing assignment or a failing grade for the course itself. See [http://cse.unl.edu/ugrad/resources/academic\\_integrity.php](http://cse.unl.edu/ugrad/resources/academic_integrity.php).

The Department requires me to report every offense to the Chair for further consideration. The key to avoiding cheating is to be totally open and transparent about any and all collaborations, noting that appropriate teamwork and collaboration will be highly encouraged. Here is some elaboration on the examples listed on the department's academic integrity webpage:

- I encourage discussions of *what* and *why*, but discussions of specific solutions or implementations are prohibited.
- Being in possession of a worked or partially-worked solution to an assignment (whether from a fellow student, from the internet, or from another source) before you have completed the assignment is unauthorized collaboration on the assignment.
- If another student has a copy of your worked solution to an assignment before s/he has completed the assignment, I will assume that you facilitated their cheating unless it can be demonstrated that they obtained the copy despite your reasonable precautions to prevent them from doing so. Students who share a computer should protect their files either by using separate accounts or by placing their coursework in password-protected folders.
- If we detect academic misconduct on group assignments, I will hold the full group responsible unless there is compelling evidence that only a proper subset of the group committed the misconduct and that the remainder of the group was unaware of the misconduct.

We will use software, including but not limited to MOSS, to help us detect academic integrity violations; however, we will also apply human judgement. We will retain your assignment submissions to be compared with future students' submissions.

- *Student Concerns and Feedback:* Your experience with remote learning in this course is important to me. If you have questions, concerns, or positive feedback, please contact me at bohn@unl.edu or 472-1803. If I am unable to respond, or you feel I've not adequately addressed your concerns, you can contact Dr. Marilyn Wolfe at mwolf@unl.edu or 472-2401. If your concern is still not resolved, please contact Dean Lance Pérez at lcperez@unl.edu or 472-5259.
- *Required Use of Face Coverings for On-Campus Shared Learning Environments:* As of July 17, 2020 and until further notice, all University of Nebraska–Lincoln (UNL) faculty, staff, students, and visitors (including contractors, service providers, and others) are required to use a facial covering at all times when indoors except under specific conditions outlined in the COVID 19 face covering policy found at:

<https://covid19.unl.edu/face-covering-policy>. This statement is meant to clarify classroom policies for face coverings:

To protect the health and well-being of the University and wider community, UNL has implemented a policy requiring all people, including students, faculty, and staff, to wear a face covering that covers the mouth and nose while on campus. The classroom is a community, and as a community, we seek to maintain the health and safety of all members by wearing face coverings when in the classroom. Failure to comply with this policy is interpreted as a disruption of the classroom and may be a violation of UNL's Student Code of Conduct.

Individuals who have health or medical reasons for not wearing face coverings should work with the Office of Services for Students with Disabilities (for students) or the Office of Faculty/Staff Disability Services (for faculty and staff) to establish accommodations to address the health concern. Students who prefer not to wear a face covering should work with their advisor to arrange a fully online course schedule that does not require their presence on campus.

Students in the classroom:

1. If a student is not properly wearing a face covering, the instructor will remind the student of the policy and ask them to comply with it.
2. If the student will not comply with the face covering policy, the instructor will ask the student to leave the classroom, and the student may only return when they are properly wearing a face covering.
3. If the student refuses to properly wear a face covering or leave the classroom, the instructor will dismiss the class and will report the student to Student Conduct & Community Standards for misconduct, where the student will be subject to disciplinary action.

Instructors in the classroom:

1. If an instructor is not properly wearing a face covering, students will remind the instructor of the policy and ask them to comply with it.
2. If an instructor will not properly wear a face covering, students may leave the classroom and should report the misconduct to the department chair or via the TIPS system for disciplinary action through faculty governance processes.

Last updated: 09:14-2020/08/27