CMSI 284-01, -02
Computer Systems Organization/ Systems Programming

https://dondi.lmu.build/spring2020/cmsi284

Spring 2020—Seaver 100 (01), Pereira 140 (02)
TR 9:55–11:10am (01), 2:40–3:55pm (02), 3 semester hours
Office Hours: MTR 4–6pm, or by appointment

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Objectives and Outcomes

This course explores how computing systems operate at a level that is very close to the actual machines on which they run—i.e., programming with the minimum possible translation between your code and what the computer can access and manipulate directly. Long after the course concludes, my hope is that you will be able to:

1. **Encode, decode, and manipulate bit representations of different types of data.**
2. **Write programs in C, assembly language, or both at the same time.**
3. **Understand and perform computing tasks close to the system level.**

In addition to the course-specific content, you are also expected to:

4. **Follow disciplinary best practices throughout the course.**

Prerequisites/Prior Background

Programming proficiency in at least one high-level language; a prior course in data structures, such as LMU's CMSI 281. A familiarity with current hardware components and specifications is also beneficial but not absolutely necessary.

Materials and Texts

This course does not have a preassigned textbook, with materials consisting primarily of assorted websites, articles, videos, and sample code to be made available online. However, the following sources can serve as foundational reading:

- Brian Hall and Kevin Slonka, *Assembly Programming and Computer Architecture for Software Engineers*, Prospect Press, 2018
- David Goldberg, "What Every Computer Scientist Should Know About Floating-Point Arithmetic," *ACM Computing Surveys* **23**(1), March 1991

In addition, these works can be used as supplementary or reference material:

- Brian Kernighan and Dennis Ritchie, *The C Programming Language*, 2nd Edition, Prentice-Hall, 1988 (some syntax has been superseded by the latest version of C, but the book still stands as a seminal work to know about and continues to contain key ideas and concepts directly from the language's creators)
- Intel Corporation, *The Intel 64 and IA-32 Architectures System Developer's Manual*, 2016 (available online—do a web search on the title)

Course Work and Grading

Your final grade will be based on the percentage of the points you get for the following deliverables against the total number of possible points:

GitHub and YouTube account listing	20 points
Encoding drills 1	100
Encoding drills 2	100
Encoding drills 3	100
C programs 1	100
C programs 2	100
Assembly language	100
Mixed language programs	100
Total	720 points

Percentages ≥ 90% get an A– or better; ≥ 80% get a B– or better; ≥ 70% get a C– or better. I may nudge grades upward based on qualitative considerations such as degree of difficulty, effort, class participation, time constraints, and overall attitude toward the course.

Term Portfolio

Your accumulated assignments for the semester comprise the *term portfolio*—the final, definitive artifact that demonstrates the course's outcomes. It is how you show whether you have, indeed, accomplished the objectives of this course.

An assignment's number is its due date in *mmdd* format, and it is always due by 11:59:59.999pm of that date. Point values are based on the state of your assignments at that moment.

Bit-Level Encoding, Decoding, and Manipulation

Your portfolio will include exercise sets meant to establish bit-level knowledge of the following kinds of values:

- Numbers
    - Integers
    - Rational & real approximations
- Characters
- Machine instructions

Demonstrate outcomes *1a–1c* and subsets of *4d–4f* to maximize the points for these assignments.

Assembly Language and C Programming

The second major type of work in your portfolio is software. Programming work includes:

- Selected programs and algorithms in C
- Selected programs and algorithms in Intel x64 assembly language
- Mixed-language programs using calling conventions to invoke assembly language code from C and vice versa

Demonstrate outcomes *2a–2d*, *3a–3c*, and *4a–4f* to maximize the points for these assignments.

Version Control

Version control is an indispensable part of today's computer science landscape in industry, the academe, and the open source community. We use version control heavily in this course: make sure that you get the hang of it.

None of the assignments can be completed (well) overnight; they should be the result of steady progress from the moment they are assigned to the date they are due. "One and done" submissions will negatively affect the final score.

Workload Expectations

In line with LMU's *Credit Hour Policy*, the workload expectation for this course is that for every one (1) hour of classroom instruction (50 scheduled minutes), you will complete at least two (2) hours of out-of-class work each week. This is a 3-unit course with 3 hours of instruction per week, so you are expected to complete $3 \times 2 = 6$ hours of weekly work outside of class.

Attendance

Attendance at all sessions is expected, but not absolutely required. If you must miss class, it is your responsibility to notify me about this and keep up with the course. The last day to add or drop a class without a grade of W is January 17. The withdrawal or credit/no-credit deadline is March 20.

Academic Honesty

Academic dishonesty will be treated as an extremely serious matter, with serious consequences that can range from receiving no credit to expulsion. It is *never* permissible to turn in work that has been copied from another student or copied from a source (including the Internet) without properly acknowledging the source. It is your responsibility to make sure that your work meets the standard of academic honesty set forth in:

http://academics.lmu.edu/honesty

Americans with Disabilities Act

Students with special needs as addressed by the Americans with Disabilities Act who need reasonable modifications, special assistance, or accommodations in this course should promptly direct their request to the Disability Support Services Office (DSS). Any student who currently has a documented disability (physical, learning, or psychological) needing academic accommodations should contact DSS (Daum 224, x84216) as early in the semester as possible. All discussions will remain confidential. Please visit *http://www.lmu.edu/dss* for additional information.

Topics and Important Dates

Correlated outcomes are shown for each topic. Specifics may change as the course progresses. University dates (italicized) are less likely to change.

January	Overview; computer system organization; numeric and character encoding *(1a–1c)*
January 17	*Last day to add or drop a class without a grade of W*
February	A simple computer *(1c, 2c, 2d)*; C programming *(2a, 2b)*
March	Processors; the Intel 64 architecture; assembly language programming *(2c, 2d, 3a, 3b)*
March 9–13	*Spring break; no class*
March 20	*Last day to withdraw from classes or apply for Credit/No Credit grading*
March 31	*Cesar Chavez Day; no class*
April	System calls *(3c)*; executable files *(3a, 3b)*; mixed language programming *(2a–2d, 3a–3c)*
April 8–10	*Easter break; no class*
May 5	*Last set of term portfolio assignments due*

You can view my class calendar and office hour schedule in any iCalendar-savvy client. Its subscription link can be found on the course web site (it's too long to provide in writing).

Tentative Nature of the Syllabus

If necessary, this syllabus and its contents are subject to revision; students are responsible for any changes or modifications distributed in class or posted to the course web site.

Course Evaluations

Student feedback on this course provides valuable information for continued improvement. All students are expected to fairly and thoughtfully complete a course evaluation for this course. This semester, all course evaluations for the Seaver College of Science and Engineering will be administered online through the Blue™ evaluation system. You will receive an email notification at your Lion email address when the evaluation form is available. You may also access the evaluation form on the Brightspace dashboard during the evaluation period.

A few minutes of class time will be reserved for you to complete a course evaluation within a fortnight before finals week. Please bring a laptop, smart phone, tablet or other mobile device to class on this date so that you can access the online evaluation platform.

Course Outcomes

1 Encode, decode, and manipulate bit representations of different types of data.

1a	*Numbers (integers; rational & real approximations)*	This is the class where you get to "see" the information we use in the same way that current computing machines truly represent them. Encoding, decoding, and manipulation will be performed both manually and in code that you write. You may check your work with tools available online but you may *not* use those tools to do the work for you.
1b	*Characters*	
1c	*Machine instructions*	

2 Write programs in C, assembly language, or both at the same time.

2a	*Operate on strings at the storage level.*	These outcomes pertain to specific features of the languages involved. General correctness, presentation, and other best practices that apply to *any* kind of programming are covered by learning objective 4.
2b	*Use pointers, arrays, and address references.*	
2c	*Perform computations on registers and main memory.*	
2d	*Perform machine-level comparisons and jumps.*	

3 Understand and perform computing tasks close to the system level.

3a	*Compile and link object code.*	These outcomes focus on computing activities that we frequently take for granted—but *someone* somewhere needs to know how to do this. The takeaway here is to demystify these activities and expose what's "under the hood."
3b	*Follow and use calling conventions.*	
3c	*Invoke system calls.*	

4 Follow disciplinary best practices throughout the course.

4a	*Write syntactically correct, functional code.*	Code has to compile. Code has to work. No errors, no bugs. Use unit tests as much as possible.
4b	*Use coding best practices, demonstrating principles such as DRY, proper separation of concerns, correct scoping of variables and functions, etc.*	This is the basis of good software design. It makes software easier to maintain, improve, and extend. Heed feedback well. *What you learn here will apply to future classes.*
4c	*Write code that is easily understood by programmers other than yourself.*	This outcome involves all aspects of code readability and clarity for human beings, including but not limited to spacing & indentation, proper naming, presenting code in a manner that is consistent with its structure, documentation & comments when appropriate, and adherence to conventions or standards.
4d	*Use available resources and documentation to find required information.*	The need to look things up never goes away. Remember also that the course instructor counts as an "available resource," so this outcome includes asking questions and using office hours.
4e	*Use version control effectively.*	In addition to simply using version control correctly, effective use also involves appropriate time management, commit frequency, and descriptive commit messages.
4f	*Meet all designated deadlines.*	