

CMSC 445: Compiler Design

Fall 2023

<http://marmorstein.org/~robert/Fall2023/cs445.html>

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Lecture (Stevens 118): 12:00pm – 12:50pm MWF

Office Hours(Stevens 109): 2:00 – 2:45pm (TWR) 1:00 – 2:45pm (F) *or by appointment*

To make an appointment to see me, please contact me by e-mail or Slack and send me your schedule. Include as much detail as you can about why you need to see me (this saves time). In general, I need at least 24 hours of notice to schedule an appointment outside of my usual office hours.

Course Description: A course covering the basic theory and techniques of compiler and code translation systems. Topics include lexical analysis, parsing, and code generation, and the various techniques used when handling differing source language classes. A programming intensive course. Also covered are the techniques of top-down and bottom-up parsing. **3 credits.**

Prerequisite: **CMSC 201 AND CMSC 208.**

Student Learning Outcomes: By the end of the course, the successful student will be able to:

- construct a lexical scanner
- implement a top-down or bottom-up parser
- explain the major challenges of code generation and optimization

Course Requirements: The largest part of your grade (50%) will come from successful completion of programming projects. The final exam and the midterm exam will each count for 10% of your grade. Quizzes, discussions, and homework assignments will comprise an additional 25%. The remainder of your grade (5%) will come from participation.

Course Structure and Student Expectations: This course will be a project-driven seminar style course. Each week, you will receive a reading assignment. You should take notes on the reading and come to class prepared to discuss it. In addition to regular attendance in discussions and lecture, you should expect to spend roughly six hours a week reading the textbook, completing projects, and working on homework exercises.

Textbook: The textbook for this course is “Compilers: Principles, Techniques, and Tools, 2nd edition” by Aho, Lam, Sethi, and Ullman, Addison-Wesley, 2006, ISBN: 978-0321486813 (also called the “Dragon Book”). I will also post links on the course web site to other resources you may find helpful.

Accessibility Resources, Sexual Misconduct, Mental Health, and Intellectual Property: This course adheres to the university policies found at <http://www.longwood.edu/academicaffairs/syllabus-statements/>.

Grading Policy: Your final grade in this course is computed using a weighted average of your scores on each assignment. The weights for each category are given in the course requirements section of this syllabus and can be used by applying the following formula:

$$\text{Final Grade} = 0.50 * \text{Project Grades} + 0.25 * (\text{Homework and Quizzes}) + 0.05 * \text{Participation Grade} + 0.10 * \text{Midterm Exam Grade} + 0.10 * \text{Final Exam Grade}$$

Each of the category grades (such as Projects) can be computed by summing the points you’ve earned on each assignment in that category and dividing by the total number of points possible. Numeric grades are translated to letter grades using the following grading scale:

	100-91: A	90: A-
89: B+	88-81: B	80: B-
79: C+	78-71: C	70: C-
69: D+	68-64: D	
63 or lower: F	(There is no grade of D- in this course. Anything below a 64 is failing)	

Late Work:

In general, I do not accept late work or grant extensions on assignments unless you have a serious medical or family emergency which prevents you from completing the assignment on time (however, see “Slip days” below). In such cases, you do not need a doctor's note, but you must notify me of the circumstances within a reasonable amount of time.

Since slip days do not apply to homework or quizzes, I may occasionally be persuaded to grant extensions on these assignments. However, in cases where I grant such extensions, I will impose a penalty of 25% per day overdue.

All requests for extensions (whether for an emergency or not), MUST be submitted by e-mail within a reasonable amount of time (typically twelve hours from the original due date). This e-mail should outline (in detail) the reasons your work is late. Granting of extensions is entirely at my discretion – if you have not turned an assignment in on time, you should expect to earn a 0%.

Slip Days:

You will be allocated a fixed number of slip days at the start of the semester. You may use your slip days to extend the due date of one or more *programming projects*. You can use all of your slip days on one assignment or you may use them over multiple assignments.

Slip days are calculated from the minute the assignment is due until you turn it in. The number of slip days used is rounded *up* to the nearest integer value. That means that if you turn an assignment in 24 hours and 1 minute after the due date, you will use up *two* slip days. The slip day clock runs over weekends and holidays. If a lab is due on Friday and you turn it in on Monday, you will have used three slip days, not one. Slip days cannot be shared, traded, bought, or sold, but can occasionally be earned by participation in relevant campus activities I select.

Attendance:

I expect you to attend class unless you are sick or engaged in a school-sponsored sport or extracurricular activity. Please do NOT come to class if you are sick. Instead, contact me within 12 hours of the absence to check whether you've missed any work and make arrangements to make up any missed quizzes. You should also make arrangements to get notes from another student in the class. You should also check the course web site for announcements, new assignments, and other important updates.

I will rely primarily on your honor for enforcement of the attendance policy. However, I will keep a record of your attendance. In accordance with Longwood policy, missing more than 10% of scheduled class time (5 class sessions) to unexcused absences may, at my discretion, result in loss of one letter grade and missing 25% of class or more (14 sessions), whether excused or not may result in an automatic failing grade.

Sexual Misconduct, Mental Health, Intellectual Property, and Disability Statements: This class follows Longwood policy as described at <http://www.longwood.edu/academicaffairs/syllabus-statements/>.

Students that require accommodations are encouraged to contact the professor and the Accessibility Resources Office to work out a plan. See <http://www.longwood.edu/accessibility/>

Longwood is an Honor Code institution, and students in this course are expected to abide by the tenets of the Honor Code. See <http://www.longwood.edu/studentconduct/honor-code/>

Cell Phones and Laptops:

Cell phones, music players, and laptops are to be turned off and put away during class, except as needed for the lab sessions. Violations of this policy will be considered an **unexcused** absence. I will not interrupt class to notify you if you have been counted absent for use of a prohibited device. Feel free to contact me by e-mail at any point in the semester to check on the number of absences you have in my class.

Food and Drink:

You may bring non-alcoholic beverages, including soft drinks, to class. However, please do not eat in class (it distracts me and the other students). Violations of this policy will be considered an **unexcused** absence. I will not interrupt class to notify you if you have been counted absent for violation of this policy. Feel free to contact me by e-mail at any point in the semester to check on the number of absences you have in my class.

I occasionally grant exceptions to this rule for students who must otherwise forgo lunch or have medical needs that require them to eat in class. If you feel that you need such an exception, you must make arrangements with me in advance (i.e. before bringing food to class).

Honor Code and Collaboration:

I firmly believe in the honor code. As such, I encourage you to actively collaborate with other students and to discuss homework problems. However, there is a point at which collaboration becomes cheating. To help you understand the line between acceptable discussion of a project and dishonorable behavior, I ask you to observe the following rules:

1. Exams and quizzes are to be completed entirely on your own. You may not discuss them with anyone or use any resources except those specifically outlined on the exam handout.

2. You must give proper attribution.

Whenever you receive help or use an online resource, you should comment your code to give proper credit. A simple comment like:

```
/* based on http://codewarrior.com */
```

or

```
/* Jessica helped me with the curly braces here */
```

is fine. This comment should go directly above or on the same line as the code on which you received help, so that it is clear exactly which parts of your program are original and which are not. You do NOT need to cite material you obtain directly from me (in lecture, the assignment handout, or office hours). In general, you also do NOT need to cite material taken from the textbook.

3. The work you submit should, in general, be either your own original work or material which I have provided and you have suitably modified yourself.

At no point should another student touch your keyboard while helping you with a project. ***For homework and projects, everything you turn in should be something YOU or someone in your group has personally typed or hand-written. You may NOT copy code electronically from other students or the Internet.***

You MAY NOT share code with other students using flash drives, cell phones, e-mail, web sites, floppies, CDs,

or other means unless I specifically direct you to do so. You MAY NOT print out copies of your code to share with other students (personal copies or copies to show me during office hours are fine) unless they are in your group.

You MAY use web sites, books, and the man pages as reference materials. However, you must cite them appropriately and you MUST re-type any code you find and not just download it or copy/paste it.

4. Do not copy large blocks of code from other students or the Internet.

You MAY assist other students or get assistance with simple problems like syntax errors, but you MAY NOT copy large blocks of code, such as entire classes or functions, from each other. A good guideline of what "large" means is that copying more than three complete programming statements is usually too much.

5. You are responsible for securing your code.

Helping other students to cheat is also cheating. Furthermore, it is your responsibility to make sure that other students do not use your work to cheat. Be careful with who you let access your account and report any missing files, flash drives, or other devices to me promptly.

Infractions of these policies will be dealt with harshly under the Longwood Honor Code. Any student convicted of an honor offense involving this class will automatically receive a final course grade of **F** in addition to any penalties imposed by the Honor Board. You should consider all work in this class to be pledged work, whether or not the pledge appears on the assignment.

If you have questions about the honor code policy, PLEASE ask me. It is much better to receive a late penalty on a single assignment than to fail the course and face honor board charges. You may find the scenarios at <https://integrity.mit.edu/handbook/writing-code> helpful in understanding this policy. While their honor code policy is not identical to mine it is very, very similar.

6. Do not use ChatGPT or other forms of generative AI

These tools replace practice with the skills I want you to develop, preventing you from adequately retaining course information. Perhaps more importantly, because they do not properly cite their sources (or give misleading citations), they effectively plagiarize everything they produce. Use of these tools on assignments in this course effectively constitutes plagiarism by proxy and will be treated as cheating.

Communications Policy: The best way to get in touch with me is to use **Slack**. Slack is a chat utility with clients for mobile devices and desktop computers. I recommend you install it on both types of devices. Slack will allow you to easily send me code snippets, ask questions in real time, or set up a Zoom meeting (or Google Hangout) if we need to video chat. You should sign up for a Slack account by visiting <https://longwood-cmsc.slack.com>. Use your @live.longwood.edu email address to register and you will be automatically approved.

Slack is also a good way to communicate with other members of the class. You will be invited to a public **#cmsc-445** channel in which you can discuss the projects and other course topics with other students in the class. Feel free to ask for help on this channel, but please stick to general questions rather than posting code.

I will expect you to check the **#cmsc-445** channel every day before class in case I have posted an announcement or asked you to bring something to class.

When you send me a Slack message, I instantly get a notification on my computer, tablet, and phone. Typically, I will reply to Slack messages within 24 hours (often sooner) on weekdays. While I am often available in the evening or on weekends, you may need to be patient if I am busy with other students or family obligations.

You can also reach out to me by e-mail to marmorsteinm@longwood.edu. However, please do not send me large files by e-mail. They take up space toward my limited quota on the mail server and cause me all sorts of headaches. **E-mail messages containing large files will be deleted unread.**

I am much slower at replying to e-mail (since I do not get a notification and have to log in to check it). Typically, you can expect a reply to an e-mail within 48 hours, but this may be longer on weekends, and I may not receive your message at all or may not be able to respond to it (my inbox is often over the “quota” allowed by campus I. T. and this often prevents me from using the system effectively).

If you are **asking for help with a project or homework problem**, you should attach your work to a direct message in Slack so that I can see where you are at. You should do this by using the “plus” icon to attach the file directly to your message or by copy/pasting the particular snippet of code you are working on to the body of the message.

Please do NOT attach pictures of your code taken on your phone. These are blurry and hard to read and I can’t run them to see why they are failing. If you need me to see your screen, you can take screenshots of your Unix system using the “spectacle” program (usually by pressing the Print Screen “PrtSc” key).

One last suggestion: don’t “ask to ask”. I am delighted to answer questions about the projects and homework assignments and you should feel free to ask questions at any time (yes, even 3am the night before the project is due – I MIGHT be awake and online). Asking me whether you can ask a question wastes my time and yours.

Tentative Course Schedule:

Week 1 (Aug. 21 – 25)	Introduction, Organization of a Compiler (Read Chapter 1)
Aug. 28	Last Day to Drop (by 5pm)
Week 2 (Aug. 28 – Sept. 1)	Syntax-Directed Translation, DFA Review (Read Chapter 2) Lab 0: Language Design and Computer Architecture
Sept. 4	NO CLASS: Labor Day Holiday
Week 3 (Sept. 6 – 8)	Lexical Analysis (Read Chapter 3)
Week 4 (Sept. 11 – 15)	Catchup and Project Work Week Lab 1: Lexical Scanning
Week 5 (Sept. 18 – 22)	Parsing, Grammars, and LL Parsers (Read Sections 4.1 – 4.4)
Week 6 (Sept. 25 – 29)	Bottom-up Parsing, LR Parsers (Read Sections 4.5 – 4.8)
Week 7 (Oct. 2 – 4)	Midterm Review, Midterm Exam
Oct. 5 – 6	NO CLASS: Fall Break

Week 8 (Oct. 9 – 13)	Syntax Directed Translation (Read Chapter 5) Lab 2: Top-down (Recursive Descent) Parsing
Week 9 (Oct. 16 – 18)	Catchup and Project Work Week
<i>Oct. 20</i>	NO CLASS: CCSC Eastern Conference
Week 10 (Oct. 23 – 27)	Intermediate Code Generation (Read Chapter 6) Lab 3: Bottom-up LR Parsing
Week 11 (Oct. 30 – Nov. 3)	Understanding 6502 and 6510 Assembly Code
Week 12 (Nov. 6 – 10)	Code Generation (Read Chapter 8)
Week 13 (Nov. 13 – 17)	Catchup and Project Work Week Lab 4: Code Generation
Week 14 (Nov. 20)	Project Demonstrations
Nov. 22 – 24	Thanksgiving Break: NO CLASS
Week 15 (Nov. 27 – Dec. 1)	Project Demonstrations and Final Exam Review
Dec. 6	Final Exam (Wednesday, 11:30am – 2:00pm)

Major Assignments:

Tests: There will be two exams: a midterm exam on Wednesday, Oct. 4th and a comprehensive final exam on Wednesday, Dec. 6th.

Projects: This class is heavily project-driven. You will complete four or five projects over the course of the semester. Some of these will be group projects and I will let you (in fact, require you to) choose your own groups. While I will give you some time in class to work on these, you should budget a sufficient number of hours outside of class to successfully complete the labs. Please see the tentative schedule above for due dates. You will present a demonstration of your project during the final weeks of the class.

Reading and Discussion: While I give lectures on the most difficult material from the class, I expect you to read the textbook and come prepared to discuss it with your peers. This includes taking notes on each chapter. Typically, Mondays and Wednesdays will be lecture days and Fridays will be discussion dates. Adequate preparation for discussion includes taking notes on each chapter as you read it and being prepared to share your understanding of the chapter with the rest of the class. Each discussion session will be graded and participation in discussions will count as a homework grade.

Quizzes and Homework Problems: In addition to homework assignments, I will give unannounced (pop) quizzes over topics from the reading assignments. You should expect roughly one homework assignment per week. Homework assignments will cover the material from the reading and are a good way to prepare for discussion sessions.