CS271 Computer Architecture and Assembly Language

Instructor Information

Joe Paris
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Office Hours: Tuesday/Thursday 12:00 PM–1:00 PM, Friday 11:00 AM–1:00 PM, or by appointment in my Zoom office.

Course Information

Section Number: 01
CRN: 44747
Number of credits: 4
Scheduled time/days: Monday & Wednesday, 2:00 PM–3:50 PM
Classroom: Zoom classroom link

Prerequisites

CS161 Introduction Orientation to Computer Science I with a grade of "C" or better.

Course Description

The aim of this course is to help you become a better programmer by teaching you the basic concepts underlying all computer systems. We want you to learn what really happens when your programs run, so that when things go wrong (as they always do) you will have the intellectual tools to solve the problem.

Why do you need to understand computer systems if you do all of your programming in high level languages? In most of computer science, we're pushed to make abstractions and stay within their frameworks. But any abstraction ignores effects that can become critical. As an analogy, Newtonian mechanics ignores relativistic effects. The Newtonian abstraction is completely appropriate for bodies moving at less than 0.1c, but higher speeds require working at a greater level of detail.

The following "realities" are some of the major areas where the abstractions you've learned in previous classes break down:

1. *Int's are not integers, Float's are not reals.* Our finite representations of numbers have significant limitations, and because of these limitations we sometimes have to think in terms of bit-level representations.
2. *You've got to know assembly language.* Even if you never write programs in assembly, The behavior of a program cannot be understood sometimes purely based on the abstraction of a high-level language. Further, understanding the effects of bugs requires familiarity with the machine-level model.

3. *Memory matters.* Computer memory is not unbounded. It must be allocated and managed. Memory referencing errors are especially pernicious. An erroneous updating of one object can cause a change in some logically unrelated object. Also, the combination of caching and virtual memory provides the functionality of a uniform unbounded address space, but not the performance.

4. *There is more to performance than asymptotic complexity.* Constant factors also matter. There are systematic ways to evaluate and improve program performance.

5. *Computers do more than execute instructions.* They also need to get data in and out and they interact with other systems over networks.

By the end of the course, you will understand these “realities” in some detail. As a result, you will be prepared to take upper-level systems classes at university. Even more important, you will have learned skills and knowledge that will help you throughout your career.

In detail, we set forth the following learning objectives, as activities you should be able to do after completing the course:

1. Explain common bit-level representations of numeric values (unsigned, two’s complement, floating point) and the consequent mathematical properties of arithmetic and bitlevel operations on them.
2. Recognize the relation between programs expressed in C and in assembly code, including the implementation of expressions, control, procedures, and data structures.

3. Demonstrate ability to understand basic intention of a program through its binary representation and apply these skills to debugging programs.

4. Investigate the programmer’s interaction with the underlying system through the different APIs and abstractions, including system support for process and thread control, virtual memory, and networking.

5. Analyze the consequences of imperfect system usage, such as poor memory and CPU performance, crashes, and security vulnerabilities.

6. Apply tools, both standard and self-developed, that will aid program development, including compilers, code analyzers, debuggers, consistency checkers, and profilers.

7. Apply these analytic and tool-use abilities to create reliable and efficient programs exercising the different components of a modern computing system.

8. Understand the sources of conflict that can arise when multiple threads of execution share resources, and demonstrate the ability to use synchronization constructs to mediate those conflicts.

Course Outcomes

- Differentiate between computer organization and computer architecture.
- Demonstrate the ability to simplify logical expressions.
- Describe digital logic and implement simple circuits.
- Demonstrate knowledge of machine arithmetic and logic operations.
- Demonstrate knowledge of system structures and devices.

Required Course Materials

- *Assembly Programming and Computer Architecture for Software Engineers,* Edition 2.0., Hall & Slonka, available electronically with lifetime access on redshelf.com ($46.60). You may want to search by ISBN (978-1-943153-76-3) to be sure you get the correct edition.
- An assembler. The text shows assembly code in three different syntaxes:
    - AT&T syntax using the GNU Assembler (GAS) commonly used on macOS-based machines (gas reference). This is most easily installed using Homebrew.
    - Intel syntax used by the Microsoft Macro Assembler (MASM) freely available for Windows-based computers (MASM reference). You can get MASM by installing the free Visual Studio Community edition or as a standalone install as outlined on this page.
    - Intel syntax used by the netwide assembler (NASM) freely available on Linux-based machines. (NASM reference). NASM can be installed from your distro's repositories.
- You will also need an editor of some kind.
- You will need an LBCC Single Sign-On account. If you have not already done so you can get your account using that same link. If you have any problems claiming your account please contact the Student Help Desk.
- We will be using Moodle in this course. You are not required to visit your Moodle shell before our first class, but it is highly recommended. If you have any problems logging into Moodle please contact the Student Help Desk before the beginning of the term.
- Internet access. Visual Studio, Visual Studio Code, Vim, Emacs, Xcode... doesn't matter. Use your favorite environment.
- An LBCC-provided email account.
- A Zoom account. See the linked document for information on setting up your free Zoom account.

Student Technology Recommendations

LBCC has developed the following recommendations to help enable you to be as prepared as possible for online courses, please see the recommended list of equipment below. Students who need financial assistance to purchase these resources should contact the Roadrunner Resource Center.

Recommended Equipment

- Broadband internet.
- A computer with 256GB SSD, 8G RAM, an Intel i5 6th gen processor (or equivalent functionality) and running one of the following operating systems:
    - Windows 7, Windows 8.1, or Windows 10.
    - macOS X 10.9 or later.

    - Ubuntu 12.04 or higher, Mint 17.1 or higher, Red Hat Enterprise Linux 6.4 or higher, Oracle Linux 6.4 or higher, CentOS 6.4 or higher, Fedora 21 or higher, OpenSUSE 13.2 or higher, or Arch Linux (64-bit only).
- A webcam, HD preferred.
- Headphones or speakers.

Course Work

All work, unless specifically stated otherwise, are to be submitted via Moodle.

Assignments may not be submitted via email.

Late assignments will not be accepted. No exceptions.

Unless specifically stated otherwise all written work must also be produced electronically. In addition to word-processing any written assignments, any illustrations you submit must be created using a graphics editing program. Do not submit pictures of hand-drawn or hand-written work. They will not be graded and as a result you will earn a score of 0 on the assignment. All work must be submitted as a PDF file which can be made in any modern word processor).

All programming assignments must be submitted as an appropriately named plain text document with the proper file extension. For assembly code this means a plain text file with a `.asm` extension, for C code a plain text file with a `.c` extension. When your solution consists of multiple files, regardless of their type, they must all be submitted.

It is your responsibility to ensure that you submit a readable document. Extensions will not be given for corrupted files or files submitted in a format other than those listed above. After uploading a file check your submission in Moodle to make sure it was uploaded correctly. If, when I attempt to grade your work, I cannot open/read the document, you will receive a score of zero on the assignment.

It is your responsibility to address any technical problems you are having in a timely fashion with technical support. The Student Help Desk (linked above) is available to help you with these issues.

Reading/Viewing Assignments

You should expect frequent reading and/or video viewing assignments. These assignments are to be completed prior to the next class session.

Quizzes

Quizzes will be given covering the assigned readings/viewings and must be completed before the class meeting in which the material will be discussed (and will be closed when class begins). Once you begin a quiz attempt you will have 20 consecutive minutes to complete it. You cannot pause a quiz once you have started it.

The single lowest quiz score will be dropped from your final grade calculation.

Homework Assignments

There will be a number of homework assignments given during the term. These are meant to give you the opportunity to explore, reinforce, and demonstrate your understanding of the course material. Many of these will be done in class and in pairs.

The single lowest assignment score will be dropped from your final grade calculation.

Code submitted for programming assignments that doesn't run at all or only throws errors before quitting/crashing will receive a grade of zero.

Exams

There will be a total of four exams given during the term. The time and date of the first three exams will be announced in class. The time and date of the final exam can be found on the Final Exam Schedule. The final will be given in the same room that your class was held in unless otherwise announced.

There will be no early or late exams given without prior arrangement and any such arrangements are at my discretion.

Presence

While class attendance is not graded your presence is. Presence consists of three parts: Professionalism, Punctuality, and Participation.

Come to class prepared having completed any assigned readings or viewings and with assigned work completed. Questions and comments must be relevant to the topic at hand.

Show respect for your instructor and for your fellow by paying attention when they are speaking. Do not browse the internet, play games, use your phone, or otherwise "check out" during class time.

While in class your camera should be on and you should be presentable. You should dress and act as you would if we were in person. I also expect that you will participate in class by asking and answering questions and generally engaging in the course.

If you do miss a class, you are responsible for any announcements made and materials covered in the missed class. These will be made available in Moodle. Class meetings will also be recorded and made available in the Moodle shell. You may ask other students for copies of their notes.

Grading

Assignments will be graded within seven business days of the date upon which they are due.

Questions or concerns regarding grades must be raised within seven calendar days of the grade being posted using this form. You can expect a response to your inquiry within three business days of your submitting all the required information.

When I am preparing final grades, I automatically review the work of any student who is within 1% of the next higher letter grade to determine if there are any possible additional points that could make a difference. By time you see your final grade in the course any and all possible adjustments have already been made. Other than errors in calculations grades are final as posted.

Assessment	Points Possible
Quizzes, 10 @ 10 points each	100
Homework Assignments, 8 @ 20 points each	160
Exams, 4 @ 50 points each	200
Presence, 18 classes @ 5 points each	90
Total	**550**

Points Earned	Letter Grade
≥ 506	A
505.9–445.0	B
444.9–385.0	C
384.9–330.0	D
≤ 329.9	F

Student Behavior and Expectations

You will be held accountable to the college's Student Rights, Responsibilities, and Conduct policies.

Academic Integrity

LBCC embraces excellence. We aspire to the highest ideal with honesty and integrity. LBCC does not tolerate any form of cheating, dishonesty, fraud, forgery, copyright violations or plagiarism. Students charged and found responsible for violating these policies will have serious consequences, from a failing grade on an assignment or in the course to suspension or expulsion from the college.

LBCC expects student to maintain honesty and integrity in all work, communications, and interactions. This means that we show respect for the ideas and expressions of others, respecting their right to own their research and their words. Students are expected to do their own work in class. In classes where group work is permitted/encouraged, students are urged to request clear guidance on what work may be done in group and what work is done only by the individual.

Violations of academic integrity include, but are not limited to:

Cheating – which is the use or attempted use of unauthorized material, information, electronic device, implement or study aid in, for example, any test, quiz, academic exercise or assignment without the instructor's permission;

Plagiarizing – which is the unacknowledged adoption or reproduction of the ideas, words, data or statements of others; for example, fellow students, printed materials, and internet sources;

Fabricating or falsifying – which is the unauthorized falsification or invention of any data, information or citation in an academic exercise;

Impersonating – which is assuming another individual's identity or allowing another individual to do so, for the purpose of fulfilling an academic requirement;

Facilitating – which is helping or attempting to help another commit an act of academic dishonesty; for example, making an assignment available or using a mobile device to coach another.

Students at LBCC are expected to behave honestly. Acts of academic dishonesty, including plagiarism or cheating, are serious offenses. I have the right to issue an "F" grade for the course when a student has been found to have cheated or plagiarized. Students may appeal this decision following the process outlined in the Student Rights, Responsibilities, and Conduct

handbook linked above. Additionally, I am required to report all acts of dishonesty to the Dean of Student Development.

All material submitted for a grade must be your own independent work; this includes, but is not limited to, quizzes, projects, homework, and exams. If you get help on an assignment from anyone other than college staff (professors or tutors, for example) or from any source other than those assigned by your instructor (assigned textbook reading or videos, for example) you must acknowledge their contribution on your submitted work, or you will be guilty of violation of academic integrity. This includes help from non-course tutors and websites, such as Chegg, Course Hero, and even Stack Overflow, among others. Your grade will be based on *your* understanding of the material; you will receive partial or zero credit for work done by others, depending on the circumstances. If you acknowledge the source of your work, you won't be guilty of a violation of academic integrity and will not be reported for academic misconduct although your grade will be reduced accordingly. Your only chance to make this acknowledgment is by including a citation or note in your work when you submit it. Acknowledge any help you get and let your instructor make the call. It's always safer to be honest.

Take a few minutes now to read What is Plagiarism as well as the two related articles it links to, Is it Plagiarism? My Teacher and I Don't Agree and The Turnitin Plagiarism Spectrum. You may want to bookmark the plagiarism.org website as it is a great resource for understanding and avoiding plagiarism.

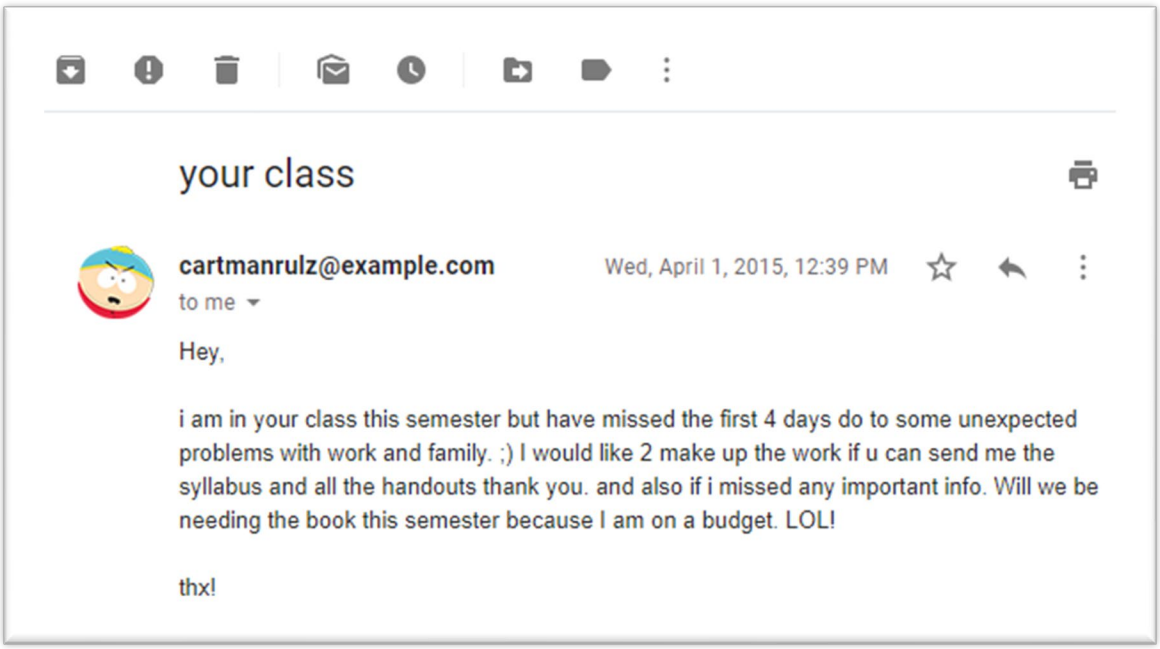
Any student who is found to have posted any course materials, in whole or in part, on any third-party website will receive a failing grade for the course.

Guidelines for Communicating with Your Professor

Feel free to address me as either "Joe" or "Professor Paris."

The best way to reach me is by email. You should normally expect a response within 1–2 business days of sending your email. Use your LBCC email to contact me. I do not respond to messages from non-LBCC email addresses as this is a violation of the Federal Family Educational Rights and Privacy Act (FERPA). The University of British Columbia offers some excellent suggestions for emailing your professor on their page Inbox (1): How to email your profs effectively.

Below is an example of an actual email I once received (the names have been changed to protect the innocent). Take a moment and see if you spot some points in the email that could have been written better.



your class

cartmanrulz@example.com Wed, April 1, 2015, 12:39 PM

to me

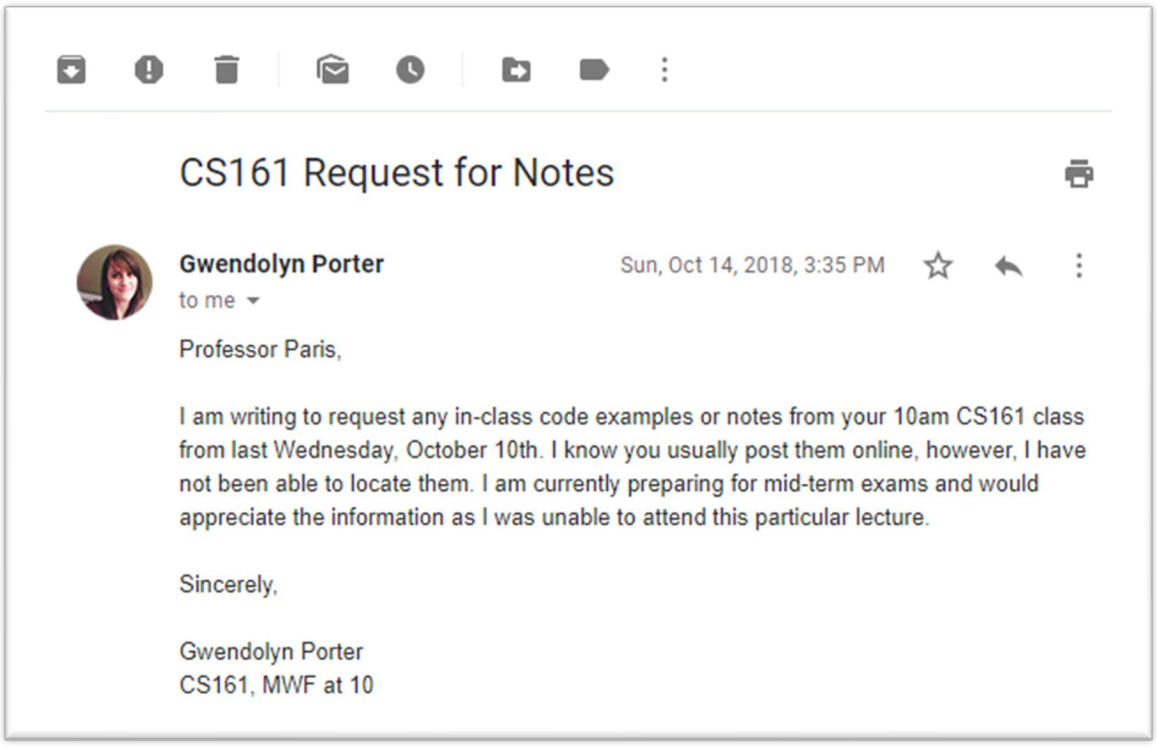
Hey,

i am in your class this semester but have missed the first 4 days do to some unexpected problems with work and family. ;) I would like 2 make up the work if u can send me the syllabus and all the handouts thank you. and also if i missed any important info. Will we be needing the book this semester because I am on a budget. LOL!

thx!

(details changed to protect the student's identity)

Following is an example of a more appropriately written email. Can you notice the difference?



CS161 Request for Notes

Gwendolyn Porter Sun, Oct 14, 2018, 3:35 PM

to me

Professor Paris,

I am writing to request any in-class code examples or notes from your 10am CS161 class from last Wednesday, October 10th. I know you usually post them online, however, I have not been able to locate them. I am currently preparing for mid-term exams and would appreciate the information as I was unable to attend this particular lecture.

Sincerely,

Gwendolyn Porter
CS161, MWF at 10

(student name and image created by the randomuser.me mock data generator)

Guidelines for Communicating with Each Other

Meaningful and constructive dialogue is encouraged in this class and requires a degree of mutual respect, willingness to listen, and tolerance of opposing points of view. Respect for individual differences and alternative viewpoints will be maintained at all times in this class. Your choice of words and use of language should be temperate and within acceptable bounds of civility and decency.

I know we all get frustrated sometimes, and it's easy to take out your frustration on the faceless person behind the computer screen. But we are all human and deserve respect. I am a person with feelings, your classmates are people with feelings. Being rude or disrespectful isn't professional, and it's certainly not going to help you pass the class.

I will not tolerate any rudeness, disrespect, sexual harassment, verbal or written abuse, badgering, insults, or inappropriate tone in student-to-instructor communication, or in student-to student-communication.

Any discussion from class that continues on any other platform such as Moodle or Discord, for example, should adhere to these same rules and expectations.

Netiquette

Netiquette is short for “Internet etiquette.” Just like etiquette is a code of polite behavior in society, netiquette is a code of good behavior on the internet. This includes several aspects of the Internet, such as email, social media, online chat, web forums, website comments, multiplayer gaming, and other types of online communication[1].

Below are some examples of good netiquette:

1. Avoid posting inflammatory or offensive comments online (aka flaming).
2. Respect others' privacy by not sharing personal information, photos, or videos that another person may not want published online.
3. Never spam others by sending large amounts of unsolicited email, chat messages, or forum posts.
4. Don't troll people in web forums or website comments by repeatedly nagging or annoying them.
5. Stick to the topic when posting in online forums or when commenting on photos or videos, such as YouTube or Facebook comments.
6. Don't swear or use offensive language.
7. Avoid replying to negative comments with more negative comments. Instead, break the cycle with a positive post.
8. If someone asks a question and you know the answer, offer to help.
9. Thank others who help you online.

See these 10 Netiquette Guidelines Online Students Need to Know from Rasmussen College for additional information.

Campus Resources

Resources and Information for COVID-19

Quite possibly the most important resource for us all this term will be LBCC’s

[1] https://techterms.com/definition/netiquette

Coronavirus/COVID-19 information page followed closely by the FAQs for Students.

The Roadrunner Resource Center

The Roadrunner Resource Center is intended for students who are facing difficulties like the loss of a job, childcare demands, healthcare expenses, or other strains on your finances or who can no longer afford to pay for things like rent, utilities, food, textbooks or other school necessities.

Student Help Desk

The Student Help Desk assists students with most computer software-related issues and other technology problems or questions, from login problems related to LBCC's online systems to questions about course-related instructional software. They also check out laptops and help anyone using library equipment such as the college's 3D printer, scanners, photocopiers, and more.

Tutoring

As an LBCC student you are eligible for up to three free tutoring sessions per week in a any of a wide variety of subjects. See the Tutoring Center web page for more information.

The Writing Center

Writing assistants are available to help you with any class in which writing is assigned and at any stage of the writing process, from brainstorming to a final draft. They also assist students with non-academic writing like scholarship essays, resumes, and creative writing. See more at the Writing Center web page.

College Policies

LBCC Email and Course Communications

You are responsible for all communications sent via Moodle and to your LBCC email account. College policy requires that you use your LBCC provided email account for all email communications at the college.

Disability and Access Statement

You and I should meet during the first week of class if:

1. You have a documented disability and need accommodations.
2. I need to know specific medical information about you.
3. You need special arrangements in the event of an emergency.

If you have documented your disability, remember that you must make your request for accommodations through the Center for Accessibility Resources (CFAR) Online Services webpage every term in order to receive accommodations. If you believe you may need accommodations but are not yet registered with CFAR, please visit the CFAR Website for steps on how to apply for services or call (541) 917-4789.

Statement of Inclusion

To promote academic excellence and learning environments that encourage multiple perspectives and the free exchange of ideas, all courses at LBCC will provide students the opportunity to interact with values, opinions, and/or beliefs different than their own in safe, positive and nurturing learning environments. LBCC is committed to producing culturally literate individuals capable of interacting, collaborating and problem-solving in an ever-changing

community and diverse workforce.

Title IX Reporting Policy

If you or another student are the victim of any form of sexual misconduct (including dating/domestic violence, stalking, sexual harassment), or any form of gender discrimination, LBCC can assist you. You can report a violation of our sexual misconduct policy directly to our Title IX Coordinator. You may also report the issue to a faculty member, who is required to notify the Coordinator, or you may make an appointment to speak confidentially to our Advising and Career Center by calling 541-917-4780.

Public Safety/Campus Security/Emergency Resources

The LBCC Safety & Loss Prevention Office exists to promote a safe environment where members of the LBCC community can study, work, and engage with each other and our communities.

Public Safety is also responsible for lost and found.

In an emergency, call 911. Also, call LBCC Campus Security/Public Safety at 541-926-6855 and 541-917-4440.

From any LBCC phone, you may alternatively dial extension 411 or 4440. LBCC has a public safety app available for free. We encourage people to download it to their cell phones. Public Safety also is the home for LBCC's Lost & Found. They provide escorts for safety when needed. Visit them to learn more.

Filed under, “I Can’t Believe I Have to Say This, But…”

- I will not grade any quiz, exam, or assignment if it has or appears to have blood, mucus, or any other bodily fluid on it.
- All assigned problems must be completed in order for you to receive full credit. If you only answer one question out of ten but you answer that question perfectly it does not mean you get 100% for the whole assignment. Scores are based on the total number of points possible, not the number of points you attempt.
- I will not pre-grade your assignment before the due date.
- If you write two answers, I will grade the one that is wrong.
- No, you can’t retake the final exam because you did poorly.
- Yes, copying stuff that someone said in a YouTube video word for word without understanding a word of what you wrote is still plagiarism. So is re-using an assignment you did for another class (or another section of this class).
- Booked vacations are not a reason for an excused absence.
- Do not buy tickets for anything before the final exam.
- You may not, under any circumstances, post any course materials on any third-party websites.
- Asynchronous courses put a lot of the onus on YOU to keep up with the work. You are not guaranteed any reminders throughout the term. You are adults and should keep up with your own calendar. You should also check your student email often. This is how I communicate with you, and I will not continually repeat myself in emails after I have already posted or sent the information.
- It is important for you to understand that high school and college are very different. In high school, you may have been permitted to turn in work as late as you like, to redo

assignments or quizzes until you were satisfied, and to complete extra credit work. This is not the case in this college-level course. There are no late assignments, make up work, redoing of assignments, or extra credit. These are course policies; they are not opportunities for negotiation. Any requests for such will be ignored unless there is a documentable extenuating emergency.

- I have noticed a prevalent attitude of, “it doesn’t hurt to ask.” Yes, it does. If I have already made clear my policies and expectations, asking me to violate them damages your credibility as a student. One day you may ask for something that is truly reasonable given an emergency situation, but by then your reputation will precede you. Do not be “the boy who cried wolf;” it is not a respected position.
- College is not a fee-for-service arrangement. You are not paying me. You are paying tuition to the for all kinds of things, very little of which actually “pays my salary.” Salaries are more commonly paid out of government funds, including grants. You start with a zero in college courses and earn your points from there. I am not “giving” you grades or “taking away” points. You have nothing to begin with and build your own score based on what you do and how well you do it (not simply on effort). What I offer you is an opportunity for education, not a grade.
- I know you don’t like group work. No one likes group work. But it is part of life. When group work is assigned you are expected to participate. If you are assigned to your group, that is your group–you don’t get to make your own because you don’t like the one you are in.
- Assignments, exams, or deadlines in other classes do not constitute an excuse for not completing your work in this class on time. The same goes for demands placed on you by your personal life.
- “I did the assignment but forgot to turn it in” falls into the same category.
- The message we often get from school is that the key to happiness and success in life is getting the right answer and not making mistakes. Then every error you see while programming feels like a personal attack or a sign of incompetence. In reality, those error messages are trying to be helpful. In CS and programming, you are going to make mistakes. I make mistakes. Everyone makes mistakes. Every day. The only people who don't make mistakes are those who aren't programming anymore; people who have left the game. So cut yourself some slack.

Other

Any and all questions or circumstances not explicitly described in this syllabus or by college board policies or administrative rules are left to the sole discretion of the course instructor.

Changes to the Syllabus

I reserve the right to change the contents of this syllabus. You will be given notice of any such changes and the current version of the syllabus will always be available in Moodle.