

# Computer Systems

CAS CS210 - Fall 2016

<https://piiazza.com/bu/fall2016/cs210/home>

<https://piiazza.com/bu/fall2016/cs210>

<http://learn.bu.edu>

Lectures: Tuesday and Thursday 2:00pm-3:30pm Kenmore Classroom Building (KCB) 101  
Discussions: Monday 8-9AM, 9-10AM, 10-11AM, 11AM-12PM, 12-1PM & 7-8PM Location  
Engineering Annex 304 (EMA 304)

	Instructor	Teaching Fellow	Teaching Fellow
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Office	Math and Computer Science (MCS) 293	MCS Undergraduate Lab (EMA) 302	MCS Undergraduate Lab (EMA) 302
Office Hours	Tuesday 9:00-10:30, Thursday 4:00-5:30	Wednesday 8:30-10:00, Thursday 5:30-7:00	Wednesday 8:30-10:00, Friday 8:30-10:00

*Acknowledgements: This syllabus includes and modifies material from Professor Ibrahim Matta.*

**You are required to gsubmit a copy the syllabus to the TF in your first discussion session indicating that you have read and understood its contents.**

## Important Dates

Last Day to DROP Classes **without** a 'W' grade is Wednesday, Oct 12, 2016.

Last Day to DROP Classes **WITH** a 'W' grade is Thursday, Nov 10, 2016.

## Course Description

This course takes a programmer's perspective to learn about the inner structure of computer systems, the design and implementation of abstractions that enable humans to use computers efficiently, the basics of C and assembly programming, the mapping between C and assembly, and between assembly and machine language, and the role of operating system software. Our goal is to learn what a "beautiful" computer system is and how it works. Quoting an Italian painter named Carlotti:

Beauty is the summation of the parts working together in such a way that nothing needed to be added, taken away or altered.

We will also learn how to become strong ("brilliant") programmers who write fast and reliable programs. Quoting Albert Einstein:

Computers are incredibly fast, accurate, and stupid; humans are incredibly slow, inaccurate and brilliant; together they are powerful beyond imagination.

CS 210 is a principal course for computer science majors. It provides background for courses in the systems area such as operating systems, compilers, networks, not to mention more advanced courses in computer architecture.

## Prerequisites

This course assumes that students have a solid background in Java or C++ programming from CAS CS 111 or equivalent. CS 112 is also recommended, but not essential for students with strong programming skills. A solid working knowledge of operating systems, such as Unix/Linux and Windows, is also assumed. CS 131 or MA 293 is important for the material on Boolean logic and data representation.

## Textbooks

Required **CSAPP** Text: Randal E. Bryant and David R. O'Hallaron, <http://csapp.cs.cmu.edu/>, "Computer Systems: A Programmer's Perspective", 3rd. Prentice Hall, 2016, ISBN-13: 978-0-13-610804-7

Required **CBook** Text: Stephen G. Kochan, [http://www.barnesandnoble.com/w/programming-in-c-stephen-g-kochan/1117773030?ean=9780321776419&st=PLA&sid=BNB\\_DRS\\_Core+Shopping+Textbooks\\_00000000&2sid=Google\\_&sourceId=PLGoP40&k\\_clickid=3x40&kpId=9780321776419](http://www.barnesandnoble.com/w/programming-in-c-stephen-g-kochan/1117773030?ean=9780321776419&st=PLA&sid=BNB_DRS_Core+Shopping+Textbooks_00000000&2sid=Google_&sourceId=PLGoP40&k_clickid=3x40&kpId=9780321776419), "Programming in C. Edition 4", ISBN-13: 9780321776419. (An approachable book on the C language.)

All books are available from the BU bookstore.

Two optional books you might find useful are:

Optional: Brian W. Kernighan and Rob Pike, "The UNIX Programming Environment", Prentice Hall, 1984. (Another Classic Text).

Optional: K.N. King, "C Programming: A Modern Approach", Second Edition, W. W. Norton & Company, 2008.

## Online Organization

The primary resources for the class is the course piazza <http://piazza.com/class#fall2016/cs210>. Please ensure you are registered on the site. If you have any questions or difficulties email the TF. Finally information regarding grades will be maintained on the course blackboard site (<http://learn.bu.edu>).

## Lecture Conduct

**You are expected to attend all lectures and be an active participant. No messaging or surfing is allowed in class. All electronic devices including phones, tablets and laptops must be silenced and put away unless being used for note taking. If you are using**

**them for other purposes you will be asked to leave class.** If used for note taking you are required to inform the professor and will be required to email an electronic version of the notes to the professor at the end of the lecture.

Once the lecture has begun and the door's closed you will need to knock and ask to enter. Avoid these situations by arriving on time and planning appropriately.

## Grading

Your final grade will be determined approximately as follows:

Midterms	30%	Average of the two midterm exams. The midterm exam average will be tentatively weighted 60% of the best grade and 40% of the lower grade.
Exam	20%	Final exam
Assignments	45%	Several Programming Assignments/Labs and Problem Sets (roughly 20% on problem sets and 25% on programming)
Attendance	5%	Short quizzes may be given throughout the semester to make sure you are doing the readings on time, and also as a measure of attendance.

Grading (except for the final exam) is done by a number of class graders, under the direct supervision of the Teaching Fellow and the professor. If you have an issue with a grade (homework or exam), please contact the Teaching Fellow. Only if the issue is not resolved to your satisfaction, please contact the professor. Grades must be appealed within two weeks of receipt.

## Midterms and Exam

There will be two midterm exams and one final exam, which will include all material covered from the beginning of the semester until the day of the exam. All exams will be closed books. You will be permitted to bring one 8.5 by 11 inch sheet of notes with you to the exams. There will be absolutely no make-up exams, except for medical emergencies. In that case, blue slips from Health Services will not be accepted; you must justify your medical problem with a letter from a doctor, specifying the period of time during which you were unable to attend one of the exams.

The two seventy-five minute in-class midterms held during the semester on **Oct 6 and Nov 3**. These dates are not flexible. The final will be held during the assigned exam slot. Please plan your work and travel plans at the end of the semester accordingly.

If you are found consulting any other material than what is provided or specified it will be considered as possible academic misconduct. This includes electronic devices this encompasses answering calls or messaging. If you need to leave the room for any reason including the restroom you are expected to ask for permission and you will not be allowed to return. Please plan appropriately.

## Assignments

A large fraction of the course evaluation is based on several major programming assignments (PAs) in C or assembly language. We will also post “pencil and paper” problem sets to help prepare you

for tests and exams. Problem sets (PSs) may also involve smaller scale programming exercises, e.g., write or debug small programs, etc.

Assignments will be available on-line. **All assignments will be submitted electronically NO hard copies will be accepted.** Check for assignments regularly and start early! Bring problems, concerns and request for help to the UA, TF and professor as early as possible. The UA, TF and professor are available and want to help you but it is up to you to make use of us.

## Late Policy

Each assignment will have a due date. If late submissions are allowed for an assignment, there will be 10% penalty per day for late submissions. But, **no late assignments will be accepted after one week from due date**, and the last day to submit any late assignments is December 12, 2016. Extensions may be granted only for religious holidays and certified medical reasons.

No incompletes will be given, except for reasons of dire illness shortly before the end of the course, and only if a significant amount of work has been completed (e.g., attending lectures, handing in most assignments, and attending the midterms).

## Problem Sets

At various points in the term you will be assigned problem sets. These problem sets are to confirm your knowledge of the material. In general they are good practice for the material, and its format, to be covered on the midterms and exams. These will be graded and solutions will be posted after their due date.

## Programming Assignments

All necessary tools and software for completing the assignments are available on the CS machines – 64-bit Intel-compatible Linux machines: csa2, csa3. These systems will be used to grade your programming/lab assignments. You may access these machines from the undergraduate lab systems. The TF will provide information and help with accessing the systems. Although you may use your own machine, it is your responsibility to ultimately port your assignment to our CS machines to make sure they are graded correctly.

Again we will use the CS machines – 64-bit Intel-compatible Linux machines: csa2, csa3 – to grade your programming/lab assignments. **Although you may use your own machine, it is your responsibility to ultimately port your assignment to our CS machines to make sure they are graded correctly.**

Each assignment will specify what you need to submit and how it will be graded. If you are unclear what is required for a particular assignment or its grading consult the TF well before the due date.

## Submission

Problem Sets assignments are to be handed in using the slotted homework (drop-off) inbox (located at the bottom), labeled "CS-210", in the hall outside of MCS 137 by 1:00 pm on the day they are due (**unless otherwise specified**). Late assignments must be time-stamped by a CS Office Staff and left in the Teaching Fellow's mailbox (neither in the CS-210 slotted homework inbox nor the

Instructor's mailbox). Do not hand in your assignment in the class or during office hours. Do not hand in your assignment by slipping it under the office door of the Instructor.

Graded Problem Sets will be available for pick-up from one of the handout/pick-up "open" boxes (located at the top), labeled "CS-210", in the hall outside of MCS 137.

If you believe that there is a chance that your assignment will be lost by the course staff, then here are two ways you can protect yourself: (1) make a copy of your assignment before handing it in, and have the CS office time-stamp your copy of the assignment; or (2) "gsubmit" an electronic version of your submission (see "gsubmit" notes on piazza) - you can type and submit your write-up in text, Word, or PDF, or if handwritten, you can scan your write-up and submit a PDF. The timestamp on your electronic submission should also indicate submission by the due date/time. Claims for "lost" assignments will be considered only if accompanied by a time-stamped (hard or electronic) copy of what you handed in. There are no exceptions to this rule.

Programming Assignments must be submitted using "gsubmit" (again see notes on piazza for details). Grades for the programming assignments will be posted to Black Board.

## Quizzes

Short quizzes maybe given in lectures or discussion session. Make sure you are doing the readings on time.

## Office hours

The professor, TF and UA will hold office hours. The purpose of the office hours of the professor, TF and UA is to answer specific questions or clarify specific issues. Office hours are not to be used to fill you in on a class you skipped or to explain entire topics. Please come to class and to your discussion sessions.

**To reach the professor, TF and UA at times other than office hours, please use piazza.**

## Teaching Fellow, Undergraduate Assistant and Discussions

Students are expected attend the weekly discussion section that they have been assigned to. The Teaching Fellow will lead the discussion sessions. The objectives are: to present material on "C" programming, reinforce the concepts covered in the lectures, and answer questions (or provide clarifications) regarding the homework and programming/lab assignments. The Teaching Fellow will post information to piazza as necessary.

In addition to the discussion the Teaching Fellow will hold office hours in the <http://www.cs.bu.edu/labs/> undergraduate lab EMA302.

The Undergraduate Assistant (UA) will additionally hold office hours. As need arises the UA will hold focused sessions to help with particular topics. The UA will as well update piazza as needed.

## Tutoring

In addition to the discussion sessions, UA and TF office hours and the professor's office hours you may also get extra help during the TF tutoring hours scheduled in the CS lab <http://www.bu.edu/cs/resources/tutoring/>. Note that terminal assistants in the CS lab are not supposed to help with course material, but to maintain the lab environment.

## SYLLABUS

The syllabus below indicates the dates for midterms, and assignments. These are fixed and not flexible, please plan your term appropriately. With respect to the lecture and discussion topics the dates are approximate and subject to change. Speed and level of coverage will depend to some extent on the maturity and background of the class. We will announce additional details to Piazza.

In the syllabus **CBook** refers to text entitled “Programming in C” and CSAPP refers to the text entitled “Computer Systems: A programmer’s perspective”. The readings indicated are required (detailed section-by-section reading assignments are noted).

Lectures, however, will not be restricted to text material or what is on online version of the lecture slides. Lectures may cover additional or alternative material. **You will be responsible for all material covered in the lectures.**

## A comment about C

We will make heavy use of C programming language because its syntax and semantics are closer to assembly language concepts. C is more suitable for exposing low-level system details and achieving higher performance in real implementations. If you know C++, you should not be distracted by this since C++ is mostly an extension to C. C and C++ both share many of the same fundamental programming constructs. C, however, lacks support for object-oriented programming, templates, lambda's and other high-level features.

Warning the syntax of the Java Programming language was derived from C but as programming languages their semantics are very different. C is heavily influenced by the underlying resources and behavior of the real hardware of a computer. Whereas Java was developed around an abstract virtual machine model whose goal is to facilitate high-level programming and portability.

Be careful not to assume Java semantics and behavior when working with C. There are aspects of C, particularly pointers, explicit dynamic memory allocation, and formatted I/O, that do not exist in Java. The “Programming in C” required text is an approachable book that can be read cover to cover to obtain a good handle on the language.

## Detailed Syllabus

Date	Activity/Topics	Readings	Assignments
09/06/16	<i>Welcome and Syllabus</i>		syllabus
09/08/16	<i>Intro</i> Introduction to Computer Architecture & Organization, Software Hierarchy.	CSAPP:Ch.1	
09/12/16	Discussion: C & gsubmit Primer	CBook:Ch2	gsubmit syllabus
09/13/16	<i>Machine Oriented Programming via C</i> : Memory, Registers and Instructions	CBook:Ch10,11	PS1: OUT
09/15/16	<i>Data Representation I</i> : Logic Gates, Boolean Algebra, Binary, Conversion between Number Systems, Data sizes & Endianess, Character Codes, Bit-level & Logical Operations in C.	CSAPP:Ch.2 (Excluding 2.3.4-2.3.7)	
09/19/16	Discussion: UNIX, GNU tools, Compilation & Debugging + Discussion of Data Lab	TBA	
09/20/16	<i>Data Representation II</i> : Integer Numbers, size conversions and casting, logical vs arithmetic shifts & Floating Point Numbers	CSAPP:Ch.2 (Excluding 2.3.4-2.3.7)	PA1:OUT
09/22/16	<i>Computer Arithmetic I</i> Addition, Subtraction, and Operations in C	CSAPP:Ch.2 (Excluding 2.3.4-2.3.7)	PS1:IN
09/26/16	TBA	TBA	
09/27/16	<i>Instructions I</i> : Intel Instruction Set Architecture (ISA): arithmetic, data transfer, addressing modes, control instructions, ...	CSAPP:Ch.3	PA1:IN, PA2: OUT, PS2:OUT
09/29/16	<i>Instructions II</i> : Intel Instruction Set Architecture (ISA): arithmetic, data transfer, addressing modes, control instructions, ...	CSAPP:Ch.3 (Excluding 3.6.6, 3.9.2, 3.13, 3.14)	
10/03/16	Discussion: Midterm Review	TBA	
10/04/16	<i>Instructions III</i> : Intel Instruction Set Architecture (ISA): arithmetic, data transfer, addressing modes, control instructions, ...	CSAPP:Ch.3 (Excluding 3.6.6, 3.9.2, 3.13, 3.14)	
10/06/16	Midterm 1		
10/10/16	Columbus Day Holiday, Discussion Suspended		
10/11/16	Substitute Monday : Discussion: MidTerm Takeup		
10/12/16	FINAL DATE TO DROP WITHOUT "W"		

Date	Activity/Topics	Readings	Assignment
10/13/16	<i>Instructions IV</i> : procedures, Arrays & Structures, Assembly versus Machine Language.	CSAPP:Ch.3 (Excluding 3.6.6, 3.9.2, 3.13, 3.14)	PA2A:IN
10/17/16	TBA	TBA	
10/18/16	<i>Instructions V</i> : procedures, Arrays & Structures, Assembly versus Machine Language.	CSAPP:Ch.3 (Excluding 3.6.6, 3.9.2, 3.13, 3.14)	PS2:IN
10/20/16	<i>Instructions VI</i> : procedures, Arrays & Structures, Assembly versus Machine Language.	CSAPP:Ch.3 (Excluding 3.6.6, 3.9.2, 3.13, 3.14)	
10/24/16	TBA	TBA	
10/25/16	<i>Instructions VII</i> : procedures, Arrays & Structures, Assembly versus Machine Language.	CSAPP:Ch.3 (Excluding 3.6.6, 3.9.2, 3.13, 3.14)	PA2B:IN, PA3:OUT,
10/27/16	<i>Program Optimization, Loading</i> : Program Translation, Linking, Loading, and Optimization.	CSAPP:7.1-7.9, and 5.1-5.6)	
10/31/16	Midterm Review	TBA	
11/01/16	<i>Program Optimization, Loading</i> : Program Translation, Linking, Loading, and Optimization.	CSAPP:7.1-7.9, and 5.1-5.6)	
11/03/16	Midterm 2		
11/07/15	Midterm Takeup	TBA	
11/08/16	<i>Memories I</i> : Memory Hierarchy, Locality, Caches: Direct Mapped & Performance, Multi-level Caches.	CSAPP:6.1.4, and 6.2-6.5)	PA3:IN, PS3:OUT, PA4:OUT
11/10/16	<i>Memories II</i> : Memory Hierarchy, Locality, Caches: Direct Mapped & Performance, Multi-level Caches.	CSAPP:6.1.4, and 6.2-6.5)	
11/10/16	FINAL DATE TO DROP (WITH "W")		



11/14/16	TBA	TBA	
11/15/16	<i>Memory &amp; Operating systems, Virtual Memory I: Pages and Page Tables, Dynamic memory allocation, Exceptions.</i>	CSAPP:9.1-9.6.1, 9.9, 8.1, and 8.2	
11/17/16	<i>Memory &amp; Operating systems, Virtual Memory II: Pages and Page Tables, Dynamic memory allocation, Exceptions.</i>	CSAPP:9.1-9.6.1, 9.9, 8.1, and 8.2	
11/21/16	TBA	TBA	
11/22/16	<i>Input/Output I</i> OS: Memory-mapped & Instructions, Interrupts, Direct Memory Access (DMA), Disks, ...	6.1.2, and 11.1-11.3	PA4:IN, PA5:OUT
11/23/16	Thanksgiving Recess, Class Suspended		
11/28/16	TBA	TBA	
11/29/16	<i>Input/Output II</i> OS: Memory-mapped & Instructions, Interrupts, Direct Memory Access (DMA), Disks, ...	6.1.2, and 11.1-11.3	PS3:IN
12/01/16	<i>Input/Output III</i> OS: Memory-mapped & Instructions, Interrupts, Direct Memory Access (DMA), Disks, ...	6.1.2, and 11.1-11.3	
12/05/16	TBA	TBA	
12/06/16	TBA		
12/08/16	Review		
12/12/16	Review	TBA	PA5:IN

## Academic Conduct

Academic standards and the code of academic conduct are taken very seriously at our university. Please take the time to review the CAS Academic Conduct Code if you are unfamiliar with the contents. See the <http://www.bu.edu/academics/resources/academic-conduct-code/> for the CAS Academic Conduct Code, in particular regarding plagiarism and cheating on exams. Copies of the CAS Academic Conduct Code are also available in room CAS 105. A student suspected to violate this code will be reported to the Academic Conduct Committee, and if found culpable, the student will receive a grade of "F" for the course.

Assignments must be completed individually. Discussion of issues in computer systems is encouraged, but representing the work of another person as your own is expressly forbidden. This includes "borrowing", "stealing", copying programs/solutions or parts of them from others. We may use an automated plagiarism checker. Cheating will not be tolerated under any circumstances. Handing in your own work a day or two late will affect your grade far less than turning in a copy of someone else's work on time!

Any resources, including material from other students (current or past), that are used, beyond the text or that provided by the TF or professor must be clearly acknowledged and attributed. Using such material may at the discretion of the TF or professor result in a lower grade. However, if such material is used and not acknowledged and attributed, it will automatically be considered as possible academic misconduct.

## Signature

The following signature confirms that I have read and understood the material in the syllabus for CS 210 Fall 2016.

**Full Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_