

CS 2214 COMPUTER ARCHITECTURE & ORGANIZATION FALL 2018

SYLLABUS

1. Professor : Haldun Hadimioglu

Office : 10.009 2MTC

haldun@nyu.edu
<http://cse.poly.edu/haldun>

Tel : (646) 997-3101
Fax : (646) 997-3609

NYU Tandon School of Engineering, Computer Science and Engineering
Six MetroTech Center, Brooklyn, New York 11201

- Degrees : B.S. and M.S. in Electrical Engineering and Ph.D. degree in Computer Science
- Involved in the undergraduate Computer Engineering program administration
- Areas : Computer architecture, parallel (multi-core) processing, reconfigurable and nano systems



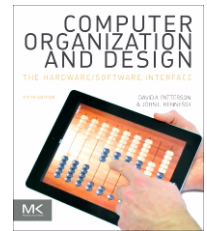
2. Prerequisites : *One* of the following two :

- CS2204 (Digital Logic and State Machine Design, C- required)
- CS2134 (Data Structures & Algorithms, C- required) & MA2314 (Discrete Math)

3. Textbook :

Computer Organization and Design : The Hardware/Software Interface, D. A. Patterson and J. L. Hennessy, 5th edition, Morgan Kaufman, 2014. ISBN : 978-0-12-407726-3

- Publisher's web site, <http://books.elsevier.com> has a large amount of material. Students are strongly suggested that they study them. The web site has various sections related to the chapters and tutorials, software packages and other supporting material.
 - ➔ Make sure it is the **MIPS** version of the book ! It should **not** be ARM nor RISC-V.



4. What is asked from college graduates :

- **Good technical and non-technical skills + competency + grit !**
- **Adaptable, flexible and team player !**
- **Problem solver + systems oriented in a global environment !**

You may have also heard the following :

- You are **creative** and have **learning** as your target ! You **know how to learn fast !**
- **Good solid technical knowledge + learning fast + interpersonal skills**
- You have **analytical** and **synthesis** skills
- You have team work skills : **Interacting** with people to solve problems !
- You have good **documentation skills !**
- You are a **critical thinker !** You **discover** and **explore !** You are **lifelong learner !**

5. How to be successful in your college years and after graduation :

- Knowledge is **infinite** and it consists of pieces of information that are **dependent** on each other in infinite ways.
- Learning is **not** instant ! It requires **physical changes** in the brain = **Plasticity !** That is, neurons in your brain are **rewired** as you learn. Rewiring the brain is **not** easy. It requires **constant** effort
- Applying/using what is learned is **not** instant ! One needs time to apply/use the knowledge acquired, meaning additional rewiring in the brain is needed.

Otherwise, students try to recover by themselves. They just take exams. Professors cannot help them since these students are not around. It gets worse for students as the semester progresses and so no one can do anything = It becomes a **vicious cycle** = **Those students who need help are not around to get help !**

6. Why Computer Architecture ? Computer architecture is about **designing computers**, designing microprocessors, memory subsystems.

➤ Students who know hardware are good at **software** = **(Operating Systems + Applications)**.

7. Course Objectives : *What will you learn ?* Computer architecture & including instruction set design and computer organization, including the central processing unit (CPU, core) & memory hierarchy.

8. Course Outcomes : *What will you be able to do once the course is completed ?* Design and analyze computer architectures (instruction sets), CPUs (cores) and memory hierarchies.

9. Course topics : CS 2214 is about **digital systems** examples include, microprocessors, GPUs, custom chips, memory chips, etc. CS 2214 also studies instruction sets run by microprocessors and their design.

➤ It emphasizes designing **microprocessors** and **memory components** that make up computers.

➔ The **finite-state machine (FSM)** approach is used to design digital systems.



10. The course format :

The course stresses what industry wants and categorizes them : *Intellectual, technical* and *non-technical*:

1) The *intellectual* goals are that students **learn how to learn fast** and are **critical thinkers**. This is necessary during one's lifetime = The more you learn, the better for you !

2) *Technical* goals are for a successful technical career : Acquiring skills to be **systems oriented** and a **problem solver** as well as acquiring the necessary course content which is *digital systems* :

➔ **Main technical topic : Digital systems**, such as microprocessors, computers, calculators, DVDs, iPhones. The course focuses on developing a computer, by designing its *architecture* and then the *organization (microarchitecture)* layers :

⇒ Designing the architecture : Machine language instruction set design & programming.

⇒ Designing the organization includes learning the skills to design a computer with a single processor (single-core) and understand its subsystems and their interaction. The processor, one of the three subsystems of a computer, is the Central Processing Unit, the **CPU**. The other two subsystems are the **memory** and **Input/Output (I/O)** controllers. The computer we design is named **EMY** and is based on a commercial microprocessor, the **MIPS**.

⇒ Digital system design is in the context of state machine design & **EMY** computer which is a subset of the MIPS system.

3) The *non-technical* goals include acquiring and improving skills needed for **interacting with** and **managing people** in a global environment. They are needed in the technical world which is **team-based** and is **global**.

11. Course structure :

A **Computer Science and Engineering** Department course

Lecture section :

- **A : 16968**, Monday and Wednesday, 10:30 - 12:20

Recitation Sections :

- **A (17146)**, Friday 10:30 - 12:20)
- **B (17147)**, Friday 4:30 - 6:20)
- **C (17148)**, Friday 12:30 - 2:20)
- **D (17529)**, Friday 2:30 - 4:20)
- **E (20140)**, Friday 12:30 - 2:20)
- **F (20141)**, Friday 2:30 - 4:20)

12. Course web page : NYU Classes : Course handout files are at the course web site

13. CS 2214 Recitations :

Recitations aim at reinforcing and complementing the lectures. They help students understand subjects discussed in class better. Recitation sessions are given by teaching assistants (TAs).

- Recitations cover **new** topics besides covering lecture topics in detail. They also present practical aspects of topics covered during the lecture. In addition, the recitations are intended to discuss homework assignments. However, homework questions will **not** solved !
- Students in each recitation section form **3-** or **4-**member teams by the *third* week of the semester. Team members do the homework assignments together until the end of the semester.
- Students register to the recitation section that is for their lecture section. Each section has one hour and 50 minutes a week. Students need to attend their recitation section to be able to work with their teammates. Attendance is recorded at every recitation.

14. Homework :

There are six homework assignments. The homework is submitted by teams.

- Students are expected to **show the work** (intermediate steps) to get full credits on a question. Showing work helps students improve their documentation. The homework is graded by TAs. Although, the homework does not affect the term grade, it can help raise grades as explained below.
- Homework assignments have relevant questions and answers to help learn chapters and solve homework problems. Students need to study them **before** they solve homework problems, not before exams.

15. Exams : There are **two** 110-minute midterm exams and a 2-hour final exam, covering class and recitation topics.

- Students are expected to **show the work** (intermediate steps) to get full/partial credits on a question. That is, both the final answer and the steps to get it, the approach, are important.
 - ➔ Showing the approach also helps students acquire and improve their documentation skills, critical for the technical world.
 - ⇒ In order to facilitate this, the exams are open book exams : Students can use their own material, i.e. their books, notebooks, homework and handouts during the exams. Note that once the exam starts there is no sharing.
 - ⇒ Students must prepare for the exams as if they are closed book exams !
- In addition, remembering the following is needed during the exams :
 - ➔ No multiple answers to a question,
 - ➔ Precise answers to questions, no answers like “the rest is similar,”
 - ➔ Answering the question asked, u
 - ➔ Use the exam booklet space well: For example, start a new question on a new page.

Overall, students are expected to show their technical knowledge and documentation

16. Term Grade : The numerical term grade calculation is as follows: :

25% Exam I

30% Exam II

45% Final Exam

- The homework does not affect the term grade directly but it is taken into account when a student's term grade is near a grade "border." Also, taken into account are attendance and recitation performance. If they are good, the grade is raised. Finally, the professor may change the term grade computation.

17. Office Hours :

The professor has an **open-door** policy that if he is not busy, students can ask questions in his office. If a student wants to see the professor at a certain time, he/she makes an appointment with the professor.

- Students are requested that they see the professor to ask questions. Broadcast messages will be sent to the class to make announcements. Please note that grades are not given out to students via email or telephone. Students need to see the professor to learn their grades.
- TA assignments and their contact information will be given later in the semester.

18. Material Coverage :

The **tentative** schedule together with the textbook chapter coverage is shown below. Students will be given additional material in class. Note that midterm exams may be given **earlier** or **later** than shown :

Day(s)	Subject	Chapters
Sep 5, 10	Introduction. Computer systems overview. Layered computer design	1, A, E
Sep 10, 29, 12, 17, 19, 24, 26, Oct 1, 3	Instruction set design and the MIPS architecture	1, 2, 3, A, E
Oct 17	Exam I : It is tentative. It can be earlier or later	HW : 1 - 2
Oct 3, 9, 10	Digital system design fundamentals	1, 4, A, B, D
Oct 15, 22, 24	The EMY computer organization. EMY CPU design. Hardwiring	1, 4, A, B, D
Nov 14	Exam II : Cumulative : It is tentative. It can be earlier or later	HW : 1 - 4
Oct 29	EMY CPU design. Microprogramming	1, 4, A, B, D
Oct 31, Nov 5, 7, 12	Performance. Pipelining	1, 4, A, B
Nov 19, 26, 28, Dec 3, 5, 10	Semiconductor memory. Memory hierarchies	1, 5, A, B
Dec 12	High-speed computer design and future projections	1, 4, 6, A, B, C, D
TBA	Final Exam : Cumulative	All the above chapters

19. References :

Students are suggested that they study **recent** computer architecture books since the field advances rapidly. The following references are recommended with respect to their relevance to the course and the textbook :

- a) *MIPS RISC Architecture*, G. Kane and J. Heinrich, Prentice-Hall, 1992.
- b) *MIPS Assembly Language Programming*, R. L. Britton, Prentice-Hall, 2004.
- c) *Computer Systems : A Programmer's Perspective*, 3rd edition, Randal E. Bryant and David R. O'Hallaron, Pearson, 2016.
- d) *Computer Systems*, 5th ed., J. Stanley Warford, Jones & Bartlett, 2017.
- e) *Computer Organization and Architecture : Themes and Variations*, Alan Clements, Cengage Learning, 2012

- A book giving insight on microprocessor design from the concept phase to the production phase : *The Pentium Chronicles : The People, Passion, and Politics Behind Intel's Landmark Chips*, R. P. Colwell, John Wiley, 2005.
- A book describing how and why technical work in computer design and development is a small part of a larger picture that also includes emotions, ambitions and conflicting goals of many people involved : *Dealers of Lightning : Xerox Parc and the dawn of the Computer Age*, Michael A. Hiltzik, Harper Business, 1999.

Students are also suggested that they read the following book that describes learning by mistakes : *Little Bets: How Breakthrough Ideas Emerge From Small Discoveries*, Peter Sims, Simon and Schuster, 2011.

20. ABET Core a-k Competencies :

- a) Students apply mathematics, science and engineering knowledge to design and analyze advanced systems.
- c) Students design a digital system that meets the desired speed, space and cost constraints.
- e) Students identify, formulate and solve engineering problems.

21. Reminders about the course:

Students need to read and remember web pages whose links are also provided at the course web site :

- 1) **NYU Code of Conduct web page** : <http://engineering.nyu.edu/files/SACCoFC2-2-16.pdf>, including *academic misconduct*, which is a part of the Student Code of Conduct document.
- 2) **NYU-SOE Life web page with links to Student Affairs, Public Safety, Students Resources and other** : <http://engineering.nyu.edu/life>.

In addition, students need to keep the following in mind :

a) Keeping contact with the professor and discussing personal matters in professor's office help you considerably

b) A successful course experience : To enjoy the course as much as possible and be ready for the follow up courses, students need to be committed to the course

- **Attending classes and labs and doing the work** are needed.

c) Students must realize that every action they take has consequences. Making assumptions and decisions on the course (the exams, lectures, labs, the homework and attendance) without asking the professor often lead to problems for students.

d) A reason for a low grade is missing classes and labs. Even if one gets the notes, it does **not** help. This is because :

- The notes taken from the board may not be correct.
- Someone taking the notes may not write down all the verbal comments and suggestions made by the professor.
- Attending classes and labs forms better memory because of visual (seeing the writing on the

board), audio (listening to the professor) and tactile (writing down the notes) inputs.

- During lectures and labs, the professor refers to earlier lectures and labs (past topics, comments, suggestions, etc.) which refreshes students' memory and further reinforces their knowledge.

Overall, students learn and remember more. Finally, since their memory is fresh, students save time when they study for exams.

e) Missing an exam is **not** a minor case. A careful assessment is made to excuse a student or to grant an incomplete to a student. The professor makes the decision. The decision is made also based on the information by the student's academic department and the Student Affairs Office.

- One of the requirements to excuse a student is that at the time the student is not able to take the exam, he/she **be in good standing in class**, i.e. has good attendance, a good homework performance, a good recitation performance and a good exam performance : The professor wants to see that the student has been committed to the course and learning the material has been his/her main objective.
- A student who is excused from a midterm exam is **not** given a make-up exam. The weight of the midterm exam is distributed to the other exams at the discretion of the professor. The make-up exam for the final exam will be harder than the one given to the whole class.

f) If a student experiences problems, including health/personal problems, he/she immediately contact **Deanna Rayment** who is the Coordinator of Student Advocacy, Compliance and Student Affairs. Her contact information is :

- **deanna.rayment@nyu.edu**
- **(646) 997-3046**
- **LC 240C**

g) For a course, the semester is over when the final exam is over. Students are **not** given extra work, a project, a make-up exam or any other kind of special treatment to raise their grade during or after the semester.

h) Some students do not know/follow NYU-SOE and CS2204 rules and regulations nor seek advice from Tandon staff. Students are strongly suggested that **they speak with the professor**, the TAs, the major advisor, the personnel of the Student Affairs Office, and the Counseling Center for a better experience.

22. Moses Center Statement of Disability :

If you are a student with a disability who is requesting accommodations, please contact New York University's Moses Center for Students with Disabilities at (212) 998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations.

Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at RH 042 in Brooklyn ((646) 997-3451) and 726 Broadway on the 2nd floor in Manhattan ((212) 998- 4980). *Please do this at the start of the semester.*