CS 6133 COMPUTER ARCHITECTURE I FALL 2019

SYLLABUS

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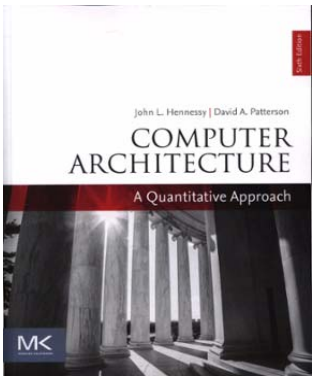
NYU Tandon School of Engineering, Computer Science and Engineering
Six MetroTech Center, Brooklyn, New York 11201

- 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 :

- CS 2214 ≡ Undergraduate Computer Architecture

3. Textbook :



Computer Architecture : A Quantitative Approach, **6th edition**, J. L. Hennessy and D. A. Patterson, Morgan Kaufmann Publishers Inc., 2019.

- Publisher's web site, **http://books.elsevier.com** has a large amount of material, including Appendices D through L of the textbook. Students are strongly suggested that they study the web site material and print the appendices that will be used especially during the exams.
  - ✦ Students need to print the appendices !

Finally, students will be provided with handouts and slides to supplement their reading.

4. Why Computer Architecture I : Our course is about computer hardware !

- Students who know computer hardware are good at **software** (**Applications+Operating Systems**).
  - ➔ Students who know computer hardware will **not** get caught by major computer hardware technology shifts.

5. Course Objectives : *What will you learn ?* Computer architecture, unpipelined CPU design, memory hierarchies, pipelined CPU design and high-speed CPU design.

6. Course Outcomes : *What will you be able to do once the course is completed ?* Design and analyze computer architectures, design and analyze CPUs, design and analyze memory hierarchies and design and analyze high-speed CPUs.

7. Course topics : CS6133 is the **first** course **on computer hardware**, with an emphasis on designing microprocessors

- A **RISC-V** microprocessor is designed by using the **finite-state state-machine** (FSM) approach !

8. The course structure :

A **Computer Science and Engineering** (**CSE**) Department course

Lecture Section : **16152**

- **JAB 775B**, Wednesday, 6:00 - 8:30

9. Course web page : NYU Classes :

- Course handout and presentation files are at the course web site

10. Exams : To test students for their technical knowledge and documentation

There will be a 150-minute midterm exam and a 150-minute final exam.

- ➔ **Showing work** (showing intermediate steps) is required to get full credits on a question. That is, both the final answer and the steps to get it, the approach, are important.
  - ✦ These steps are given in class. Therefore, students are expected to solve exam questions as such. 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 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,
  - ✦ Use the exam booklet space well : For example, start a new question on a new page.

Overall, students are tested for their technical knowledge and documentation

11. Homework :

There will be six homework assignments. **An assignment submitted late will not be accepted**. Students are reminded about studying the solutions provided by the textbook.

- ➔ Students will form 3- or 4-student teams by the *third* week of the semester. The homework will be submitted by teams.

- ➔ *Students who do homework are faster at sol*ving problems. Showing work (intermediate steps) is required to get full/partial credits on a question. The homework will be graded by the TAs. Although, the homework will **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.

12. Term Grade : The term grade is based on the weights of the exams :

40% Midterm Exam **60% 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 is student's attendance record. If they are good, the grade is raised. Finally, the professor may change the term grade computation. Thus, students are strongly suggested that they fulfill the requirements of the course, i.e. lectures and homework assignments.

13. Material Coverage :
All chapters will be covered, some partially, some completely this semester. Students will be given additional material in class. The **tentative** schedule is as follows :

Day(s)	Subject	Chapters
Sep 4	Introduction. Computer systems overview. Layered computer design.	1, 2, A, B, C, K
Sep 4, 11, 18	Computer Architecture : ISA principles and the RISC-V architecture	1, A, K
Sep 18, 25. Oct 2	Digital Systems ; RISC-V organization : Unpipelined CPU design (Version 0)	2, 3, A, B, C, K
Oct 23	Exam I : It is **tentative**. It can be earlier or later	HW : 1 - 2
Oct 2, 9	RISC-V organization : Pipelined CPU design (Version 1)	2, 3, A, B, C, K
Oct 16, 30	Adding FP instructions to the RISC-V pipeline (Version 2)	2, 3, A, B, C, K
Nov 6	Tomasulo RISC-V CPU (Version 3)	2, 3, A, B, C, K
Nov 6, 13	Control dependencies, precise interrupts	2, 3, A, B, C, K
Nov 13, 20	Speculative execution (Version 4) ; Superscalar execution (Version 5)	2, 3, A, B, C, K
Nov 20, Dec 4	VLIW execution, EPIC (Version 6) ;	2, 3, A, B, C, H, K
Dec 4	Vector processing (Version 7)	2, 3, A, B, C, G, K
Dec 11	Advanced computing systems ; SIMD ; GPUs ; Future of computing	2, 3, A, B, C, D, I, K, L
Dec 18	Final Exam : Cumulative : It is **tentative**. It can be earlier or later	HW : 1 - 6

14. Office Hours :
The professor has an **open-door** policy that if he is not busy, students can ask questions in his office. If the door is closed, he might be teaching or at a meeting. 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.
- There are TAs to help students. TA contact information will be given at the course web site later in the semester.

15. 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) *Structured Computer Organization*, 6th ed., A. S. Tanenbaum & T. Austin, Pearson, 2013.
b) *Computer Systems : A Programmer's Perspective*, 3rd edition, Randal E. Bryant and David R. O'Hallaron, Pearson, 2016.

c) *Computer Systems*, 5th ed., J. Stanley Warford, Jones & Bartlett, 2017.

d) *Microprocessor Architecture : From Simple Pipelines to Chip Multiprocessors*, J.-L. Baer, Cambridge, 2010.

e) *Speculative Execution in High Performance Computer Architectures*, D. A. Kaeli and P. Yew, Editors, CRC Press, 2005.

f) *CPU Design : Answers to Frequently Asked Questions*, C. M.R. Thimmannagari, Springer Verlag, 2005.

g) *Computer Organization and Architecture : Themes and Variations*, Alan Clements, Cengage Learning, 2012

h) *Computer Architecture : Pipelined and Parallel Processor Design*, M. J. Flynn, Jones & Bartlett, 1995

i) The UC Berkeley RISC-V Manual is at https://content.riscv.org/wp-content/uploads/2017/05/riscv-spec-v2.2.pdf

- 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 involved in computer design and development is just a small part of a larger picture with 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.

16. ABET Core 1-7 Competencies :

1) Students identify, formulate, and solve complex engineering problems by applying principles of engineering science, and mathematics.

2) Students apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

17. 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 **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, the homework and attendance) without asking the professor often lead to problems for students.

d) A reason for a low grade is **missing classes**. 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 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 the professor refers to earlier lectures (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, 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 CS 2204 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.

18. 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 (CSD) 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 726 Broadway on the 3rd floor in Manhattan ((212) 998- 4980). ***Please do this at the start of the semester.***