

CS 401- Computer Architectures*

Spring 2023 - 2024

Instructor Information

Name: Atıl Utku Ay
Office: FENS L026
Email: utku.ay@sabanciuniv.edu
Office Hours: Monday 09:00-11:00

Schedule

Lectures: Tuesday 09:40 - 11:30 UC G030
Thursday 10:40 - 11:30 UC G030
Lab: Thursday 11:40 - 13:30 UC G030

This is an introductory course on the architecture and organization of computer hardware.

Catalogue Data

The emphasis in this course will be the basic concepts and techniques that are fundamental for modern computers such as datapath design, pipelining, memory hierarchy, cache, and virtual memory. MIPS architecture is chosen to explain these fundamental concepts. Topics include: Instruction set design, computer arithmetic, controller and datapath design, cache and memory systems, input-output systems, interrupts and exceptions, pipelining, performance and cost analysis, computer architecture history, and a survey of advanced architectures.

Prerequisite

The class is open to any undergraduate students, who have previously taken CS 303 – Logic and Digital System Design - and scored minimum grade of D.

Tentative Outline

- **Introduction:** Computer Abstractions, Technology, Terminology, and History.
- **The Role of Performance:** Definition, Measurement and Metrics, Comparison
- **Instructions:** Operations of the Computer Hardware, Operands, and Representation of the Instructions, Procedures, and Addressing.
- **Computer Arithmetic:** Signed and Unsigned Numbers, Addition and Subtraction, Logical operations, ALU Construction, Multiplication, Division, Floating Point Arithmetic.
- **Datapath and Control:** Building the Datapath, Single-cycle and Multicycle Implementations, Control Design and Microprogramming, Exception Handling.

*All information in this document is tentative. The instructor reserves the right to make changes in the semester.

- **Pipelining:** Pipelined datapath, Pipelined Control, Data hazards and Forwarding, Pipeline Stalls, Branch Hazards, Exceptions, Superscalar and Dynamic Pipelining.
- **Memory Hierarchy:** Memory Hierarchy, The Basics of Cache, Measuring and Improving Cache Performance, Virtual Memory.
- **I/O:** I/O Performance Measures, Types and Characteristics of I/O Devices, Buses, Interfacing I/O Devices to the Memory, Processor, and Operating System
- **Multiprocessor Systems**

Textbook

John L. Hennessy & David A. Patterson. Computer Organization and Design: The Hardware Software Interface, Morgan Kaufmann Publishers, Inc.

Exam Dates

Midterm: TBA (possibly 7th - 8th week of the term)

Final: TBA (possibly 12th - 12th week of the term or scheduled by SR for the final exam period.)

Tentative Grading

- Midterm Exam 30%
- Final Exam 40%
- Term Project 10% ¹
- Lab (Total 4(±1)) 10% ²
- Homeworks (Total 4(±1)) 10% ³

The instructor has the right to have an oral interview for any grading item given in the syllabus.

- Students who will have the oral interview may be selected randomly or according to a suspicious situation observed by TAs or the instructor.
- Performance of the student in an oral examination may affect their grades of the grading item they have been called upon.
- If a student fails to show up at an oral exam, (s)he will automatically get 0 (zero).

The letter grade boundaries will be determined by the instructor at the end of the term. In order to pass the course:

¹The highest grade you can get from term project is 1.7 times of your weighted exam average. For example, if your weighted exam average is 40%, then maximum of each take-home exam grade is 68% even if you get more than that.

²The highest grade you can get from an individual lab assignment is 1.8 times of your weighted exam average. For example, if your weighted exam average is 40%, then maximum of each take-home exam grade is 72% even if you get more than that.

³The highest grade you can get from an individual take-home exam is 1.5 times of your weighted exam average. For example, if your weighted exam average is 40%, then maximum of each take-home exam grade is 60% even if you get more than that.

- The overall grade has to be higher than D/F boundary.
- The Final Exam grade must be at least 25/100.
- The Weighted Exam Average (given below) must be at least 35/100.

$$\text{WeightedExamAverage} = \frac{(\text{Midterm} \times 0.3) + (\text{Final} \times 0.4)}{0.7}$$

Make-up Policy

- There will be no make-up for homeworks, labs and term project. Students automatically get 0 (zero) from the respective assignment grade if any of them is missed.
- Make-up is only allowed for the midterm and final examinations to those with an official report and to those with an official permission notice from the university on the date of the exam in question.
- Make-up examinations may be written and/or oral.

Time Conflict Permission Policy

In general, time conflict permission requests are approved in this course ⁴. However, time conflict permission is not a permission for you not to attend some classes. Moreover, it does not mean that, time conflicts will be taken into account when planning any activity (exam, quiz, etc.) for the corresponding hour. The conflicted hour as an hour that you have reserved only for this course like other students who do not have a time conflict. It is the responsibility of the student, who took time conflict permission, to manage potential problems that may arise due to time conflict.

It is assumed that the students, who are registered to this course with time conflict permission, accept these terms.

Plagiarism Policy (Academic Integrity)

Plagiarism means presenting someone else's work as yours. This is a very serious and ethical problem. A plagiarized work may or may not be a verbatim copy of another submission. Verbatim copies are of course plagiarized ones. However, if a submission is derived from another one by partially changing some parts, this action is also plagiarism. When a plagiarism case is detected, sanctions are applied to all parties regardless of the actual source of the submission. These sanctions are as follows:

- For the midterm/final examinations,
 - students directly fail the course, even in the first offense.⁵
- For the homeworks, labs and term project,
 - for the first time, all plagiarized submission owners receive 0,
 - the second time, the student fails the course automatically.⁶

⁴The instructor reserves the right to reject any request.

⁵ Additionally, the case will be referred to the Dean's Office for disciplinary action. This course does not tolerate any breach of academic integrity (more info on <https://www.sabanciuniv.edu/en/academic-integrity-statement>)

⁶See footnote 5