(1DT093) Computer Architecture Spring 2024

Teaching Staff

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Please use the discussion forum for most Q&A. Please only email us if it concerns private matter
Note: This syllabus is based on Dr. Black-Schaffer's 1DT038 Syllabus

You are responsible for the details in this document.

Course Contents

This is an introductory course to computer architecture and will cover MIPS assembly language, the MIPS processor architecture, the memory hierarchy, input/output, performance analysis, the basic design and implementation of the data path, and the basics of parallelism in modern multicore processors. The exam for the course will cover all lecture and lab material.

Course Basics

This **lecture** of this class will be taught using the "flipped classroom" approach. Students will prepare before class by watching online lectures and participating in in-class-session to solve practice problems in groups. This method of teaching has been shown to produce substantially better student learning outcomes compared to traditional lectures because it focuses on active learning. (And it's more fun.) There are **lab-assignments** where you will do hands-on implementations on the material you learn from the lectures. Finally, you will prepare and **present** topics related to computer architecture.

Schedule

The course schedule is determined by the university. **Online lectures are due at midnight the day before the in-class-session.** The precise due dates are provided in table below Practice problems will be solved during in in-class-session on the next day.

Due Date (for bonus)	**In-class-session**	**Watch corresponding module on Studium and come into in-class-session prepared**
	18-Mar 10:15-12:00	Introduction
19-Mar	20-Mar 10:15-12:00	ISA 1
21-Mar	22-Mar 13:15-15:00	ISA 2
24-Mar	25-Mar 13:15-15:00	Arithmetic
25-Mar	26-Mar 10:15-12:00	Digital Logic
27-Mar	28-Mar 10:15-12:00	Control & Datapath
07-Apr	08-Apr 15:15-17:00	Pipeline
	12-Apr 13:15-15:00	Midterm Review
15-Apr	16-Apr 13:15-15:00	Pipeline Hazards
17-Apr	18-Apr 13:15-15:00	Branches
18-May	19-Apr 10:15-12:00	I/O
22-May	23-Apr 13:15-15:00	Caches (Long Studium Modules!)
25-May	26-Apr 13:15-15:00	Virtual Memory (Long Studium Modules!)
05-May	06-May 10:15-12:00	Parallelism
	08-May 10:15-12:00	TBD
	20-May 13:15-15:00	Final Review

Labs will also be held on campus. You are **not** required to attend lab sessions. However, we **advise** you to use the lab sessions to ask questions and get assistance. Labs are to be completed with your group and evaluated by TAs through signups. **You will be assigned meeting slots with TAs to grade your group Lab assignments.**

	Lab Assignment	**Help Sessions**	**Grading Sessions**
Lab 1	Intro. to MIPS Assembly	27th March, 8th April	9th April
Lab 2	MIPS Datapath	15th, 17th, 18th April	22nd April
Lab 3	Pipelining	29th April, 2nd May	7th May
Lab 4	Caching	8th, 15th, 16th May	17th May

Grading

There are five parts of the course that affect your grade: 1) online preparation, 2) in-class participation, 3) labs, 4) presentations, and 5) the exam.

To complete the course, you must:

- Complete *all* labs in groups of three *on time*, and,
- Complete the presentation (workshop and actual presentation), and,
- Pass the final exam.

Summary:

50% (5hp) final exam (up to 7 bonus points awarded).
30% (3hp) labs, (bonus tasks award higher grade).
20% (2hp) presentations.
You must pass all three portions to pass the course.

We estimate your time requirements will be as follows:

- Lectures: 15x2h = 30h
- Practice problems: 13x2h = 26h
- Labs: 4x10h = 40h
- Presentations: 12h (presentation preparation) + 2h (presentation workshop) 2h (presentation day) = 16h
- Exam review: 16h

This is a total of 128 hours during the quarter. (A 10.0hp course is supposed to be the equivalent of 266 hours of work, so this is "only" an 48% course load.) In the past students have told us that this course is more work than an average class but worth it. If the time you are spending exceeds the amount of time expected, please let us know.

Notes:

- Online lectures will be at *your* own pace on Studium (Check Modules). In-class sessions will be where we solve problems and have discussions.
- Bonus points are only available the first time you take the exam. E.g., not for exam retakes.
- It does not make sense to attend the in-class meetings if you have not done the online preparation. Indeed, you may harm your partner's learning if you are not prepared. Please consider this carefully before showing up unprepared.
- In-class-session problem solving are not graded to eliminate pressure from the actual learning, but we do take attendance for bonus points.
- The lab-help sessions for each lab assignment are optional: they are there for you to receive help from the TAs and classmates if you need it.

Contacting the Teaching Staff

Please use the Studium discussion forum **for all questions regarding the course material**. Only email the TAs directly if you have a private issue, such as grading or illness. This allows us to avoid duplicate answers and respond more quickly to all students. **Please feel encouraged to respond to other students' questions**. We will try to respond within one business day and no later than our next scheduled office hours. If you have not received a response in that time it is your responsibility to re-contact the teaching staff via email or in class.

Lectures

Preparation: Online Lectures

All lectures will be provided online through Studium Modules, and are due at midnight on the specified date. Lectures contain short, non-graded, self-assessment quizzes designed to help you interact with the material and tell us what we should review in class. You are expected to have viewed them and answered the quizzes before coming to class. It is disrespectful to other students if you show up in class unprepared since you will be working with them to solve problems.

You have complete flexibility as to when to watch the lectures, but **we do not recommend watching them more than a few days before the in-class session**, as you may not remember the material as well. Your performance on the online quizzes will not affect your grade, so you are encouraged to re-take any quizzes you get wrong and to see why the wrong answers are incorrect to help you learn. You can see how you did on the quizzes online after you have completed them. You are also free to rewind/review the material the lectures as much as you like, take notes online as you watch the lectures, and watch them at higher speed. **We particularly encourage you to ask questions on the survey at the end of each module.** You are expected to prepare for in class meetings by completing the scheduled online lectures quizzes.

Participation: In-class Sessions

We will spend the regularly scheduled 2x45 minute in-class-sessions doing peer/group instruction problems and solving problems in small groups. This approach has been shown to be a more effective way to learn than listening to a lecture, but it requires that the students actually work during the class meetings. The practice problems are for your benefit and will not be graded. You will not have to turn them in if you do them in class. Solutions will be made available online shortly after the in-class session.

Exam Bonus Points

As mentioned in 'Grading', you will receive up to 5 bonus points if you *prepare* for the in-class meetings and *participate* the in-class meetings. If you do this for 10 out of 12 modules, you will get +5 points. If you do this for 8 out of 12 modules, you will get +2 points. *Preparing* means watching the online lecture (and filling out the survey) by the deadline. The deadline is the midnight before the in-class session for the corresponding module. *Participating* means that you attend the in-class sessions and engage in group discussions. If you cannot *participate* due to illness or conflict in schedule, please sign up for a make-up ***before*** the in-class session. **Up to 3 make-ups per person.**

Invited lecture attendance: we are planning an invited lecture. We would like to invite you to this lecture and will offer +2 bonus points for attending. Also, there may be question(s) in the exam based on the invited lecture. However, as for this invited lecture, please note that things may change, and the invited lecture could be cancelled. (In such case the +2 bonus points will not be offered to anyone.)

Labs – in your group

The course has four labs. Students should work in groups of three to complete the labs and meet with the TA to have your lab assignment assessed. If you cannot find a group within the first week please post on the class forum and we will help you. The TAs will provide tutorials for the labs to get you started with the software, answer questions in the course forum, and will be present in the to help you with any problems you may have. **You are not required to attend the scheduled lab help sessions.** You can download all the tools for the labs to your own computer. Please check the lab write ups for more detail.

All lab assignments must be finished and graded by the TAs to pass the course. We will post how your group can make an appointment with the TAs to be graded at a future time. Your group will be graded together, however the TAs will try to ask questions to everyone to make sure everyone participated and understand their lab assignments.

All labs have bonus tasks. Each lab assignment will award up to 1 lab-bonus-point, **iff you finish and are graded *on time***. Late submissions/gradings will not award lab-bonus-points.

Lab-bonus-points	Lab grade
3 or more	5
1 or 2	4
0	3

Presentations – in your group

This course also features a presentation segment for the students. The objective is twofolds: have students study specific topics related to computer architecture, that will result in better understanding on the topic. Secondly, it will help students develop presentation skills. There will lecture on presentation skills, followed by practice workshop (*mandatory* to participate), where student groups will present to a small audience of other groups, and the student groups in the audience will provide feedback for the presenters and vice versa. Finally, we will have presentation slots for students to present to other students. More information will be provided during the presentation lecture.

Other Information

Reading (optional, but a great book)

"Computer Organization & Design: The Hardware/Software Interface" by Patterson and Hennessy. The official syllabus has been updated to the 6th edition (MIPS edition) and there are a couple of copies in the library. The 4th Edition is more accessible and you can read the e-book offered by the library. This book is very clear and easy to read, if a bit long-winded. **The reading is optional, and the exam will be based on the lecture and lab material.** However, the book is an excellent reference. Students have told us that they really appreciated skimming through the book *after* watching the lectures to get a second perspective on some topics. The reading in section 4.1-4.4 is particularly useful for the datapath lab.

Lecture	Recommended Reading	
	4th edition	**6th edition**
1. Introduction	1.1-1.9	1.1-1.12
2. Instruction Sets 1	2.1-2.7	2.1-2.7
3. Instruction Sets 2	2.8-2.10, 2.12, 2.13, 2.16, 2.18-2.19	2.8-2.10, 2.12, 2.13, 2.16, 2.21-2.22
4. Arithmetic	3.1-3.5, 3.8-3.9	3.1-3.5, 3.9-3.10
5. Logic	C.1-C.3, C.5-C.8, C.10, D.1-D.2	B.1-B.3, B.5-B.8, B.10, D.1-D.2
6. Processor 1: Control and Datapath	4.1-4.4	4.1-4.4

7. Processor 2: Pipelining	4.5-4.6	4.6-4.7
8. Processor 3: Hazards and Forwarding	4.7	4.8
9. Processor 4: Branching	4.8-4.9, 4.13-4.14	4.9-4.10, 4.15-4.16
10. I/O	6.1-6.7, 6.10, 6.12-6.13, C.9 (skip error correction in C.9)	N/A
11. Caches	5.1-5.3	5.1-5.4
12. Virtual Memory	5.4 (skip handling of faults), 5.5, 5.11-5.12	5.7 (skip handling of faults), 5.8, 5.15-5.16
13. Parallelism	2.11, 3.6, 4.10, 5.8, 6.9, 7.1-7.5, 7.10-7.13	2.11, 3.6, 4.11, 5.10, 5.11, 6.1-6.5, 6.11, 6.14-6.15

Honor Code

The standard honor code for the department applies. You are expected to have read and understood this document. (https://www.uu.se/en/students/your-rights/examination/cheating-and-plagiarism). The key definition of cheating is: "**Students who** ... by forbidden aids or **in any** other **way attempt to mislead/deceive** during a test or other student assignment which is to be assessed."

In the context of this course, the following general rules should be respected. This is not a complete list. If you have questions please contact us for clarification.

- Students work together in groups on lab assignments and are expected to contribute equally to each lab. Each lab group is expected to **be evaluated on their own work**. This explicitly means you may not download and use others code: you have to figure it out and solve it yourself. If this is not working as expected please contact the teaching staff.
- Lab assignments must be completed without referring to existing solutions. This does not prohibit you from obtaining assistance, but you may not consult solutions to the same problem. E.g., in a lab about building ALUs, it is okay to search for "how does a MUX work" but not okay to search for "how do I use a MUX in an ALU".
- This should be obvious, but it is stated here for absolute clarity: you must only fill out the online-lecture survey iff: you have watched the online lectures of that module AND you have tried the module quizzes.

Any instance of cheating will be pursued to the fullest extent of the department and university policies. Don't cheat. If you are in doubt, ask.