Course Memo

Introduction

Welcome to the course about computer organization! In this course, you will learn how a computer system is constructed. After that the course finished, you will have a fundamental understanding of how a processor is constructed, how a computer executes machine code, how memory hierarchies affect execution time, and fundamental understanding of the principles of parallel computation. On the laboratory exercises, you will write assembly and C code, see how programs are executed on an embedded hardware platform, and construct a functional single-cycle processor in a simulation environments. Finally, in groups of two students, you will construct a mini-project on a real embedded platform.

This course website is valid for both course IS1500 (taught at the KTH main campus each fall) and IS1200 (taught at the KTH Kista campus each spring). On the website, we will explicitly state if something is specific for one of the course editions. If nothing is stated, then the information is valid for both IS1200 and IS1500.

Learning Outcome

After the course, the student will be able to:

- Analyze and demonstrate how logic gates, blocks, combinational circuits, and sequential circuits work (only for IS1500).
- Implement low-level programs in the C programing language and in an assembly language.
- Analyze processor microarchitectures, with and without a pipeline.
- Explain the principles of memory hierarchies, including cache structures.
- Implement low-level programs with input-output, timers, and interrupts.
- Explain the principles of multiprocessor computers and how they can be programmed.
- Explain and describe technical solutions, both orally and in writing.

Please see the syllabi for **IS1500 (https://www.kth.se/student/kurser/kurs/IS1500)** and **IS1200 (https://www.kth.se/student/kurser/kurs/IS1200)** for more details.

Teachers

Examiner and Course Responsible

- **David Broman (mailto:dbro@kth.se)**

Lectures

- **David Broman (mailto:dbro@kth.se)**

Exercises and Seminars

- **Fredrik Lundevall (mailto:flu@kth.se)**
- **Saranya Natarajan (mailto:saranyan@kth.se)**
- **Daniel Lundén (mailto:dlunde@kth.se)**
- **Viktor Palmkvist (mailto:vipa@kth.se)**

Labs

- **Viktor Palmkvist (mailto:vipa@kth.se)**
- **Saranya Natarajan (mailto:saranyan@kth.se)**
- **Daniel Lundén (mailto:dlunde@kth.se)**

Project

- **David Broman (mailto:dbro@kth.se)** (Overall responsible, Assessment)
- **Fredrik Lundevall (mailto:flu@kth.se)** (Assessment)

- **Saranya Natarajan (mailto:saranyan@kth.se)** (Assessment)
- **Daniel Lundén (mailto:dlunde@kth.se)** (Assessment)
- **Viktor Palmkvist (mailto:vipa@kth.se)** (Assessment)

Examination

Both IS1200 and IS1500 contain the following two parts, which are reported into LADOK separately.

- LAB1 - Laboratory Work, 4.5 credits, grade scale: P, F. This part is reported as P (pass) when the student has passed Labs 1 to 4 and received a pass on the project.
- TEN1 - Examination, 3.0 credits, grade scale: A, B, C, D, E, FX, F. This part is reported after finishing the written exam. Note that it is allowed to write the exam several times to get a higher grade.

In addition, IS1500 students also have a lab in logic design:

- ANN1 - Component Demonstration, 1.5 credits, grade scale: P, F. This part is reported as P (pass) when the student passes the LD-LAB (IS1500 only)

The final grade for the course is given when LAB1 and TEN1 have pass grades (IS1200) and when LAB1, ANN1, and TEN1 have pass grades (IS1500). The final grad is the grade of TEN1.

Written Exam

The next written exam (tenta): March 11, 2020, 08.00-13.00.

Retake exam: June 2020 and January 2021.

Allowed aids: One sheet of handwritten A4 paper (both sides) with notes.

The exam has two parts:

Part I: Fundamentals

- Max 40 points (IS1200) and max 48 points (IS1500).
- 8 points for each module.
- Short questions with short answers.

Part II: Advanced

- Comprehensive questions.
- Discuss, analyze, and construct.

Grading of the Exam

Pass criteria:

To get a pass grade on the exam (A, B, C, D, or E), it is required to pass Part I of the exam. For IS1500 students, it is required to get at least 2 points on each module (excluding bonus points), and in total at least 36 points on Part I (including bonus points). For IS1200 students, it is required to get at least 2 points on each module (excluding bonus points), and to get at least 30 points in total on modules 1, 2, 4, 5, and 6 on Part I (including bonus points). Note that there is an explicit mapping between the official learning goals of the course, and the modules. That is, the criterion to pass the course is to have sufficient knowledge on all modules. The learning goal of explaining technical solutions orally and in writing is examined during labs and in the project.

Grading criteria:

Passing only Part I gives in total grade E on the exam. To get a higher grade (A, B, C, or D), the student needs to show knowledge within three different abilities, each represented as a separate question in Part II.

- **Question 1: Discuss:** Test the ability to discuss and compare different concepts present in the course. The focus of the discussion is on module 6, but other concepts from modules 1, 2, 4, 5 may also appear on the exam. The question is graded in three levels S, G, and VG, with the following criteria:

- *Satisfactory (S):* Some of the concepts in the question are clearly explained.
- *Good (G):* Basically all concepts in the question are clearly explained, and some of the concepts are related to each other, by discussing similarities and differences.
- *Very Good (VG):* Basically all concepts in the question are clearly explained, and all of the concepts are related to each other, by discussing similarities and differences.

- **Question 2: Construct:** Test the ability to correctly construct larger C and/or Assembly programs. The focus on the construction question is on modules 1 and 2. The question is graded in three levels S, G, and VG, with the following criteria:
  - *Satisfactory (S):* Some minor parts of a C or Assembly program are constructed correctly, but there are major errors or missing parts of the program.
  - *Good (G):* The majority of the program is constructed correctly, including the main flow and structure of the program, but there are a number of minor errors within the program.
  - *Very Good (VG):* The program is correct, with basically no errors.

- **Question 3: Analyze:** Test the ability to analyze C and/or Assembly programs with respect to pipelines and/or caches. The focus on question 3 is on modules 4 and 5. The question is divided into three analysis tasks, each corresponding to one of three levels of difficulty: L1, L2, and L3. The question is graded in three levels S, G, and VG, with the following criteria:
  - *Satisfactory (S):* The task at level L1 is solved correctly.
  - *Good (G):* Either the task at level L2 or the task at level L3 is solved correctly.
  - *Very Good (VG):* Both the tasks at level L2 and L3 are solved correctly.

In summary, the final grades on the exam are given as follows:

- Grade A: Passed Part I, performed an advanced project, and received three VG **or** two VG and one G on part II.
- Grade B: Passed Part I, performed an advanced project, and received one VG and two G **or** two VG and one S on part II.
- Grade C: Passed Part I, and received three G **or** two G and one S **or** one VG and two S **or** one VG and one G and one F **or** two VG and one F **or** one VG and one G and one S on part II.
- Grade D: Passed Part I, and received three S **or** one G and one S and one F **or** two G and one F **or** one VG and one S and one F **or** one VG and two F **or** one G and two S on part II.
- Grade E: Passed Part I.
- Grade FX: At least 36 points (for IS1500) or at least 30 points (for IS1200) on Part I, and at most one module with less than 2 points.
- Grade: F: otherwise

Note that these grading criteria are new for fall 2019, but the structure and content of the exam questions are very similar to previous exams.

Bonus points: It is possible to get up to 4 bonus points on the seminars. Note also that the bonus points received during this semester are only valid on the ordinary written exam, and the two following retake exam possibilities, including the exams co-located with the course IS1500/IS1200. If you are retaking this course, you are allowed (and encouraged) to do the seminars again in this course edition.

Advanced project: To get grade A or B on the written exam, the student must have completed an advanced project before the exam and within the same course year. That is, the accomplishment of completing an advanced project gives the possibility to get grade A or B on the ordinary exam when the project was completed, and on the two following retake exams. If you are retaking this course and you have completed the labs before, you need to do the project this year if you are aiming for grade A or B. If you are not aiming for these higher grades, you do not have to do the project, presupposed that you already have LAB1 reported in LADOK.

Correction of exam: Note that we will only mark (check if the solution is correct and give comments) on Part II of the exam (Advanced) if the student gets a pass or FX grade on Part I (Fundamentals).

Plussning: We allow "plussing", meaning that you are allowed to take the exam again to get a higher grade, even if you have already passed the exam. If you take the exam again and fail the exam or get a lower grade than the one in LADOK, you will keep the grade in LADOK. That is, you can not get a lower grade by doing "plussing". Note that if you are aiming for grade A or B, you still need to have passed the advanced project the same year as you are doing the exam for "plussing".

NOTE on update, January 2020: the grading criteria summary for higher grades than E has been updated since the start of the course. The difference is that it is now possible to get a higher grade even if a student failed or scored lower on some of the three questions on the advanced part.

Literature

The following is the recommended course book:

- David Money Harris and Sarah L. Harris. **Digital Design and Computer Architecture**, Second Edition, Morgan Kaufmann, 2013.
- David A. Patterson and John L. Hennessy. **Computer Organization and Design – the Hardware/Software Interface**, Fifth Edition, Morgan Kaufmann, 2013.

For details, please see the course literature page.

Lectures, Exercises, Labs, and Project

For details, see the specific pages on lectures, exercises, seminars, labs, and project.

Getting help

There are several ways to get help in the course. The main options are:

- Add a question to the Canvas discussion forum.
- Attend one of the lunch office hours (see the schedule).
- Get help from the general tutoring at EECS (Allmänhandledning). For more information about general tutoring, please see **the following page** **(https://www.kth.se/social/group/allmanhandledning/)** .

Disability

If you have a disability, you may receive **support from Funka (https://www.kth.se/en/student/studentliv/funktionsnedsattning)** .

Funka also recommends that you inform the teacher (in this case **David Broman (mailto:dbro@kth.se)**) regarding any needs you may have. Funka does not automatically inform teachers in courses.

Code of Honor

Please make sure that you are aware of and that you understand the **KTH EECS Code of Honor (https://www.kth.se/en/eecs/utbildning/hederskodex)** . **(https://www.kth.se/en/eecs/utbildning/hederskodex)**

(https://www.kth.se/en/eecs/utbildning/hederskodex)

Policy against Plagiarism

Note that all forms of cheating and plagiarism will be reported. Please see KTH's **policy for handling plagiarism (https://canvas.kth.se/courses/17831/files/2446097/download)** .

- **Labs and Project code.** You may collaborate and discuss with anyone, but you must be able to explain all code you present to us individually, including your lab partner's code. When requested in the lab and project instructions, you must clearly declare who has authored the code you show at lab examination.
- **Written reports and project abstracts.** You are not allowed to copy, cut, or paste any text into your report that is not produced by you. The only exception is if you quote text properly, and give a citation to the original source.
- **Seminar exercises.** You are allowed to discuss the solutions of the exercises, but the final solutions must be written down and solved individually by you. It is not allowed to copy solutions in any way.
- **Written Exam.** You are allowed to bring one handwritten sheet of A4 paper. You may write on both sides. The A4 paper must not be printed or copied. All other aids (for instance calculators or text books) are not allowed.

Validity of Incomplete Labs

The following rules hold for IS1500 and IS1200 students.

- Each student will have 3 attempts of being examined for each lab. The three possible attempts will be available before the course starts the next time. If you have not finished some of the labs after these three possible attempts, you will need to redo all the labs in the course (all labs for a specific LADOK entry, e.g., LAB1 or ANN1). Note that it is the number of available *possible* attempts that counts. If you select not to use one of the possibilities, it still counts as a try.
- The first possible attempt will be given during the course, that is, the ordinary lab occasion. Most of the students will finish their labs during these occasions. For IS1500 students, this is during period 1 and 2 in the fall, and for IS1200 students, this is during period 3 in the spring.
- The second possible attempt will be at the end of the course or just after the course. For IS1500 students, this will be just before Christmas. For IS1200 students, their second possible attempt will be in March/April.
- The third attempt will be the last possible time to be examined on the labs. For IS1500 students, the last time will be in March/April, and for IS1200 students, it will be just before Christmas. Note that the second attempt for IS1200 coincide with the third attempt for IS1500. The reverse is also true.
- Again, if you have not passed all labs 1,2,3,4 *and* finished the project, you will need to redo the LAB1 LADOK part again the next year (all the labs and the project). If you have already done some of the labs, you can of course reuse your own solutions, but you need to be examined on all labs again.
- LD-LAB (logic design) is just for IS1500 (not for IS1200). However, there you will first have a submission attempt, followed by a complementary work submission just a few weeks after the first submission. The third attempt for completing the lab is just before Christmas. If you have not completed it by then, you will need to redo the LD-LAB the next time IS1500 is given. Note, however, that LD-LAB is a separate LADOK entry (ANN1). As a consequence, completing this lab or not does not affect the other labs.
- For the project, you need to submit all the project descriptions and drafts on time. If you cannot show your project at the project expo, you will have to inform us well in advance, so that you can give a private demonstration *before* the project expo. If you fail the project, or you did not finish it, you can be examined for the project the next semester. For IS1200, it will be during the project expo for IS1500, and for IS1500, it will be at the project expo for IS1200. Note: if you have finished the labs but not the project within a year, you will have to redo all parts again. Hence, please make sure to finish everything on time!

The rationale for having these rules is twofold:

- It is extremely important that you finish your course the same year, and do not leave just some parts of the course unfinished. This rule with 3 possible opportunities for examination of each lab aims at getting as many students to pass as possible. We have experience of students coming back several years later with some parts unfinished, and this is not good for a student's study progress.
- It is very hard to keep track of detailed student results over many years, when different students come back several years after with just some parts left. Therefore, we strongly encourage you to finish the whole lab series direct, the same year as you started the course.

Reporting

We will only report grades to LADOK via Canvas in batches. This means that all students that have finished all labs and the project at the end of the course will be reported at the same time at the end of the course. All students that have finished parts of their course after the second lab examination attempt will be reported at the same time. Finally, all students that pass after the third attempt will be reported to LADOK at the same time.