Lecturer: Alketa Hyso – PhD in Computer Engineering.

Credits: 8

Education Cycle: Master of Science

Semester: Fall 2019

Degree: Master of Science in Computer Science

Course code: CS 485. Advanced Computer Architecture

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CONTENT:

The purpose of this course is to study in depth the advanced issues and current developments in the field of computer architecture based on the approach by Hennessy and Patterson. The course covers fundamentals of quantitative analysis, pipelining, memory hierarchy design, instruction-level, thread-level and data-level parallelism, multiprocessors, cache coherence and interconnection networks. In particular we are interest in the design of fast processors and fast memory.

LEARNING OUTCOMES

The course aims to enable students to:

- Account and argue for how modern computer systems are designed, including details about pipeline, memory organisation, virtual and physical memory, and memory technology.

- Account and argue for techniques to create and use instruction-level parallelism, memory-level parallelism, and thread-level parallelism.

- Account and argue for the design and programming of multiprocessor systems and shared memory, especially taking coherence and memory modules into account.

- Evaluate different design alternatives, using quantitative and / or qualitative analysis arguments.

BASIC CONCEPTS:

1. Processor: Data Path
2. Instruction Pipelining
3. Scheduling
4. Caches
5. Virtual Memory
6. Data-Level Parallelism
7. Thread-Level Parallelism
8. Multiprocessors
9. Communication and Synchronization in Multiprocessors.
10. Periphal Devices

COURSE OUTLINE

1. Review of basic principles of processor design.

2. Datapath design, hardwired control, microprogramming.

3. Fundamentals of quantitative design and analysis. How to evaluate and compare the performance of computers. Amdahl’s low. Benchmarks.

4. Instruction level parallelism. Data dependences and hazards. Control dependences.

5. Basic Pipelining. Forwarding in minimizing data hazard stalls. Static and dynamic branch prediction. Basic performance issues in pipelining.

6. Basic pipeline scheduling and loop unrolling.

7. Dynamic scheduling, Scoreboard. Dynamic scheduling using Tomasulo’s approach.

8. Advanced techniques for instruction-level parallelism: Hardware prediction and speculation, multiple issue.

9. Memory system design.  Memory technology. Virtual memory and virtual machines.

10. Basic cache memory design. Cache Performance. Advanced optimizations of cache performance.

11. Thread-level parallelism. Multiprocessors.

12. Centralized shared-memory and distributed-memory multiprocessor.

13. Interprocessors communication, synchronization and cache coherency protocols.

14. Data- level parallelism.

15. Peripheral Devices: Storage systems. Disk Array; Video/Audio Devices.

RESEARCH REPORT:

For the research report, you are required to write a report similar to a research paper. It should include:

- Abstract: It describes the main synopsis of your paper.

- Introduction: It provides background information necessary to understand the research and getting readers interested in your subject. The introduction is where you put your problem in context and is likely where the bulk of your sources will appear.

- Methods (Algorithms and Implementation): Describe your methods here. Summarize the algorithms generally, highlight features relevant to your project, and refer readers to your references for further details.

- Results and Discussion (Benchmarking and Analysis): This section is the most important part of your paper. It is here that you demonstrate the work you have accomplished on this project and explain its significance. The quality of your analysis will impact your final grade more than any other component on the paper. You should therefore plan to spend the bulk of your project time not just gathering data, but determining what it ultimately means and deciding how best to showcase these findings.

- Conclusion: The conclusion should state clearly what your results demonstrate about the problem you were tackling in the paper. It should also generalize your findings, putting them into a useful context that can be built upon. All generalizations should be supported by your data.

- Bibliography: Refer to any reference that you used in your assignment. Citations in the body of the paper should refer to a bibliography at the end of the paper.

ATTENDANCE:

The student, resulting in less than 75% attendance at the seminar, will not be enrolled in the final exam, and will be evaluated with M. If the student has attended the course but does not appear on the exam, he is assessed as NP (Not Present).

GRADING:

Final grades will be based on the points accumulated from all assignments submitted throughout the term

Research report 20 %

Assignement and quizes 20%

Final exam 60%

Final grades will be based on the percentage of total points represented by your accumulated points. Letter grade assignment will be based on the following criteria

Grade 5-10 progressively 41-100%.

REQUIRED TEXT(S)

Hennessy and Patterson; *Computer Architecture:  A Quantitative Approach,* fifth edition; ELSEVIER, Morgan Kaufmann, 2012, ISBN: 978-0-12-383872-8

Betim Çiço, *Arkitektura e kompjuterave*, Tirane 2010.

RECOMMENDED TEXT

Computer System Architecture, 3e – Morris Mano – Pearson, 2007

 **Approves**

**Head of Computer Science Department**

**PhD. Eljona Proko**