Faculty of Information Technology and Computer Sciences
Computer Sciences Department

CS-432
Computer Architecture
Syllabus
Spring Semester 2008/2009

Instructor

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Office: Khawarezmi 404
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Catalog Data

Concepts, ALU design , IEEE 754 format for floating-point numbers, coprocessors, design of hardwired CU and micro-programmed CU, the characteristics of instruction sets, pipelines techniques, the architecture of RISC, and CISC machines, (cache) high speed memories, I/O channels and I/O processors, parallel processing.
Note: the student audience for these lectures has had exposure to logic design and attends a hands-on assembly language programming course.

Course Objectives

After completing this course, the student should be able to:

1. Understand the internal structure of computer systems.
2. Understand computer systems with particular emphasis on computer architecture and organization, its performance, design and relation to the system software.
3. Gain an insight into nature of design process and the associated trade-offs.
4. Know how to design a computer or understand how a system works and why it performs as it does.
5. Bridge some of the software, hardware, and firmware gaps.
6. Understand the interaction between H/W and S/W at a variety of levels that offer a framework for understanding the fundamentals of computing.
7. Tie ideas from the course more closely to real world outside the computing industry.

Learning Outcomes

CO1- Demonstrate understanding of the fundamental concepts of computer technologies.
CO2- Understand the basic concepts of how to measure the performance using different metrics.
CO3- Demonstrate understanding of the MIPS instructions.
CO4- Understand how the integer and floating point arithmetic operations are performed by computers.
CO5- Develop understanding of how to build the processor datapath and control.
CO6- Recognize the importance of pipelining to enhance the performance.
CO7- Demonstrate understanding of the memory hierarchies, with emphasis on cache design.
CO8- Understand the basic concepts of storage devices, networks, and other peripherals.

Textbook

D. A. Patterson and J. L. Hennessy, Computer Organization & Design: The Hardware / Software Interface, 3rd edition, Morgan Kaufmann, 2005.

References

- Patterson D.A., Hennessy J.L., "Computer Organization & Design: The Hardware/Software Interface", Second Edition, Morgan Kaufmann, 1998 (http://www.mkp.com/cod2e.htm)
- Hennessy J.L., Patterson D.A., "Computer Architecture: A Quantitative Approach", Second Edition, Morgan Kaufmann, 1996, (http://www.mkp.com/books_catalog/catalog.asp?ISBN=1-55860-329-8)
- Shen J.P., Lipasti M.H., "Modern Processor Design: Fundamentals of Superscalar Processors", McGraw-Hill, 2005.Hwang K., Zhiwei X., "Scalable Parallel Computing: Technology, Architecture, Programming", McGraw-Hill, 1998.
- Almasi G.S., Gottlieb A., "Highly Parallel Computing", second edition, The Benjamin/ Cummings, 1994.
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- Zargham M.R., "Computer Architecture: Single and Parallel Systems", Prentice-Hall, 1996.
- Kain R.Y., "Advanced Computer Architecture: A Systems Design Approach", Prentice-Hall, 1996.
- Flynn M.J., "Computer Architecture: Pipelined and Parallel Processor Design", 1995.
- Hwang Kai, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw-Hill, 1993.
- Wilkinson B., Allen M., "Parallel Programming: Techniques and Applications using Networked Workstations and Parallel Computers", Prentice-Hall, 1999. Williams R., "Computer Systems Architecture: A Networking Approach", Addison-Wesley, 2001.
- Bhasker J., "VHDL Primer", Prentice-Hall, 1999.
- Tanenbaum A.S., "Structured Computer Organization", fourth edition, Prentice-Hall, 1999.
- Stallings W., "Computer Organization and Architecture", fifth edition, Prentice-Hall, 2000.
- Irvine K.R., "Assembly Language for Intel-Based Computers", fourth edition, Prentice-Hall, 2003.
- Sargent III M., Shoemaker R.L., "The Personal Computer from the Inside Out", third edition, Addison-Wesley, 1995.
- Brown S., Vranesic Z., "Fundamentals of Digital Logic with VHDL Design", McGraw-Hill, 2000.
- Carpinelli J.D., "Computer Systems Organization & Architecture", Addison Wesley, 2001.
- Savage J.L., "Models of Computation: Exploring the Power of Computing", Addison Wesley, 2000.
- Sanchez E., Tomassini M. (eds.), "Towards Evolvable Hardware: The Evolutionary Engineering Approach", Springer-Verlag, 1996.

Course Webpage

Local Course Webpage: http://www.it.yu.edu.jo/cs432/
Textbook Webpage: http://books.elsevier.com/companions/1558606041/

Prerequisites by Topic

1. CS136 – Computer Organization
2. Advanced Programming Skills

Topics (Tentative)

(1) Computer Abstractions and Technology
- General Introduction
- Relationship between a High-Level Language (HLL), an Assembly Language, and a Machine Language
- Compilers
- Assemblers
- Hardware: Under the cover, Manufacturing Pentium 4 Chips

(2) Instructions: Language of the Computer
- Introduction
- RISC vs. CISC
- Operations & Operands of the Computer hardware
- Representing Instructions in the Computer
- Logical Operations
- Instructions for making decisions
- Supporting Procedure Calls
- Load and Store operations
- MIPS Addressing
- Translating and Starting a program
- A C Sort Example
- IA-32 Instructions
- Fallacies and Pitfalls
- Concluding Remarks

(3) Arithmetic for Computers
- Signed/Unsigned Numbers
- Arithmetic Operations
- Floating-Point Arithmetic
- FP in the IA-32
- Coprocessors
- Fallacies and Pitfalls
- Concluding Remarks.

(4) Measuring Performance
- Defining Performance
- Relating Metrics
- MIPS, MFLOPs
- Choosing Programs to Evaluate Performance
- Calculation of Total Execution Time
- Comparing & Summarizing Performance

(5) The processor Datapath and Control
- Introduction
- Building a Datapath
- A single-cycle Datapath
- A Multiple-cycle Datapath
- Microprogramming
- Exceptions
- The Organization of Recent Pentium Implementations

(6) Enhancing Performance with Pipelining
- An Overview of Pipelining
- A Pipelined Datapath
- A Pipelined Control
- The Pentium 4 Pipeline
- Concluding Remarks

(7) Memory Hierarchy

- Introduction,
- Caches
- The Basics of Caches
- Measuring and improving cache performance
- Virtual Memory
- A Common Framework for Memory Hierarchy
- The Pentium 4 Memory Hierarchy

(8) Storage, Networks, and other Peripherals

- Introduction
- Buses and Other Connections between Processors, Memory, and I/O Devices
- Interfacing I/O Devices to the Processor, Memory, and OS
- I/O Performance Measurement
- Designing an I/O System

Recommended Reading: A Survey of RISC Architectures For Desktop, Server, And Embedded Computers.
Note: The student should train himself/ herself on the Spim Simulator to write programming Assignments.

Computer Usage

To be determined

Tests, Projects and Grading Policy

There will be three exams during the semester. All exams are closed book closed notes. The following table summarizes grade requirements in the course:

Grading Component	Points
Test #1	25%
Test #2	25%
Final Exam	50%
TOTAL	**100%**