CMPEN 431  
Introduction to Computer Architecture  
Required Course for Computer Engineering, Elective for Computer Science

Catalog Data:  Introduction to Computer Architecture (3)  
Principles of computer architecture: memory hierarchies and design, I/O organization and design, CPU design and advanced processors. Prerequisite: CMPEN 331 or CMPEN 371.

The Pentium Chronicles, Robert Colwell, Wiley Interscience, 2006.

Course Objectives:  This course is designed to give seniors in computer science, computer engineering, and electrical engineering insight into:

- The design of computer systems,  
- The design of fast computers, and  
- The design of high performance processors.

Primary Course Outcomes:  Upon completion of the course, students should possess the following skills:  
LIST OF SKILLS HERE (Different than outcomes in the next section)  
- Design and analysis of pipelined RISC computer architecture.  
- Analysis of superscalar/VLIW microarchitecture.  
- Understand memory hierarchies and memory design issues.  
- Understand I/O design issues.  
- Design of multiprocessor systems.

Relationship to Undergraduate Program Outcomes:  CMPEN 431 is the second in a sequence of computer organization and architecture courses (the first being CMPEN 331) which collectively support the following program outcomes:

- Design the electronic/logic circuits that form the basic building blocks of a computer system.  
- Design the organization and architecture of the basic components of a computer system.  
- Analyze the performance of hardware systems using probabilistic, statistical and simulation methods.  
- Design hardware support for virtual memory and understand how it is used by the operating system to manage virtual memory.  
- Given specifications, design and implement a computer system under time and budget constraints.  
- Write clear and effective prose.  
- Be able to discuss major trends in industry and current research activities within computer architecture design.

Required Topics:  An itemized list of topics including the approximate time devoted to each topic (just pull it from the course outline). At least 80% of the time must be specified explicitly. E.g.

1. course introduction (1 lecture)  
2. review of the MIPS ISA and basic architecture (5 lectures)  
   MIPS ISA and arithmetic  
   - Performance metrix  
   - MIPS datapath and control
3. Pipeline Datapath Design Issues (4 lectures)
   - Pipeline concepts
   - Overcoming pipeline hazards
4. Multiple-Issue Architectures (6 lectures)
   - Superscalar execution model
   - Superscalar front-end issues
   - Superscalar back-end issues
   - VLIW architectures
5. Memory Organization and Design (6 lectures)
   - Memory hierarchies
   - Improving cache performance
   - Virtual memory
6. I/O Organization and Design (3 lectures)
   - Peripheral architectures
   - Buses and I/O design
7. Multiprocessor Design (6 lectures)
   - Multiprocessor concept
   - Single-bus connect multiprocessor
   - Network connected multiprocessor
   - Advanced topics: CMP and SMT

Class Format: Two lectures per week. Each lecture is 75 minutes.

Professional Component: Describe how the course helps to prepare a student for their role in the work force. What skills are being developed. How the skills relate to being a computer engineering professional. Here’s what was here before.

CMPEN 431 overviews the architecture of traditional computing systems and extensively practices various hardware/architectural and software/algorithmic means that enhance performance of computer systems. Both uni-processor and concurrent systems will be investigated. Students are expected to apply basic knowledge learned in the course to design more advanced systems. Different computational models – in-order issue, in-order execute, in-order issue out-of-order execute, and out-of-order issue out-of-order execute – are studied and linked to the commercial systems. Finally, by simulating and analyzing one or two computer components students are expected to get more insight into the conceptual issues learned in the course. CMPEN 431 is a required course in Computer Engineering.

Evaluation: How students are evaluated (i.e., how grades are determined).

Author: Yuan Xie and Mary Jane Irwin
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