# EE 4720—Computer Architecture

01-1

Call Number 1822 (Spring 2007)

URL: http://www.ece.lsu.edu/ee4720

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Offered by:

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Office Hours: Monday - Friday, 9:00-10:00.

Should already know:

How to design a computer.

Will learn:

How to design a *good* computer.

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Prerequisites By Course:

EE 3755, Computer Organization.

Prerequisites By Topic:

- Logic design.
- Computer organization.
- Assembly-language programming.

Optional Text

"Computer architecture, a quantitative approach," John L. Hennessy & David A. Patterson, or "Computer organization & design," David A. Patterson & John L. Hennessy.

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Course Content

- Instruction set design.
- Pipelined processor design.
- Multiple-issue processor design.
- Caches and memory.

Topics cover modern general-purpose microprocessors.

# Graded Material

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Midterm Exam, 40%

Fifty minutes, closed book.

Final Exam, 40%

Two hours, closed book.

Yes, it's cumulative.

Homework, 20%

Written and computer assignments.

Lowest grade or unsubmitted assignment dropped.





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# Course Usefulness

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Material in Course Needed For:

- General-purpose processor designers and testers.
- Special-purpose processor designers and testers.
- Compiler writers.
- Programmers of high-performance systems.
- Answering job interview questions.

# Material Covered in This Set

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Slides and other material via http://www.ece.lsu.edu/ee4720

Web site also has homework assignments, exams, grades, and other material.

# ISA and Implementation Distinction

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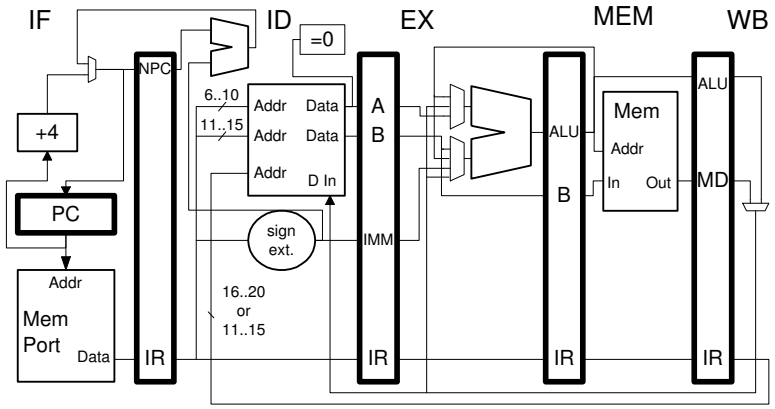
What a computer engineer does:

- Develops an *instruction set architecture* (ISA):

```
ld  r1, 0(r2)  ! Load register r1 with contents of mem at r2.
add r3, r1, r4
sw  0(r2), r3
```

- Designs hardware to execute, *implement,* the instruction set:





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Definitions

*Instruction Set Architecture (ISA):*
Precise definition of computer's instructions and their effects.

- It's all programmer needs to program machine.
- It's all hardware designer needs to design machine.

*Implementation:* [of an ISA] (noun)
Hardware that executes instructions defined by ISA.

ISA and implementation descriptions at
`http://www.ece.lsu.edu/ee4720/reference.html`.

# Some Architectures and their Implementations

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## Architecture: IBM *System/360*

Developed in 1964 for large business computers.

Designers appreciated and popularized the difference between architecture and implementation.

First planned family of computers.

Very successful, successor machines still in use under name z/Architecture.

First Implementations: Model 30, Model 75.

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## Architecture: Intel *IA-32*

Initially developed in 1978 for small systems.

First processor: 8086, implements small part of IA-32.

Major improvements in amount of memory addressable by subsequent chips, 80186, 80286 (1982).

The 80386 (1985) could host a modern 32-bit operating system.

Later chips implemented ISA extensions for multimedia and data movement ...
... and continued to incorporate microarchitectural innovations.

80486 (1989), Pentium (1992), Pentium Pro (1995), Pentium II (1997), Pentium III (1999), Pentium 4 (2000), Core Duo (2006).

Unlike System/360, the way it would be used was not forseen.

Includes unpopular features, such as small memory segments.

Nevertheless, implementations have competed well with modern ISAs.


EE 4720 Lecture Transparency. Formatted 9:15, 17 January 2007 from lsli01.
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Architecture: DEC (then Compaq, now HP) *Alpha*

An example of a *RISC* processor.

Designed for easy programming.

Designed for easy implementation.

RISC programs are larger than others, but run faster.

Developed for a 25-year lifetime.

First implementation: DECchip 21064 (1992).

Later implementations: 21264, 21364.

Implementations are usually the fastest processors.

Alas, Compaq plans to discontinue it.



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Architecture: *Itanium* (née IA-64)

First general purpose *VLIW* ISA.

ISA helps processor overcome problems in turn-of-the-century processors.

First implementation: Itanium (same name as architecture) (2000).

Radically different from other processors.

So far unproven.



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Who ISA Developed For

- Compiler writers.
- Compute-intensive library writers.
  E.g., graphics and scientific libraries.

Instruction set requirements don't change very much over time.

Scope of ISA Specification

Describes instruction codings, and what they should do.

Should specify action of all codings, used or not ...

# Implementation

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Two aspects of implementation: *organization* and *hardware*.

*Organization:*
Details of functional units, data paths, control, etc.

Also called *microarchitecture*.

This includes memory system, bus, and CPU.

*Technology (Hardware):*
Logic design and packaging.

Course focus: ISA and organization, not hardware.

# Goals (Fall 2007)

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## ISA and Implementation

Know the definitions.

Understand the difference, why at one time the distinction was not made, and how making a distinction is useful for a product line of computers.

List examples of ISAs and implementations.

## Define organization and technology.