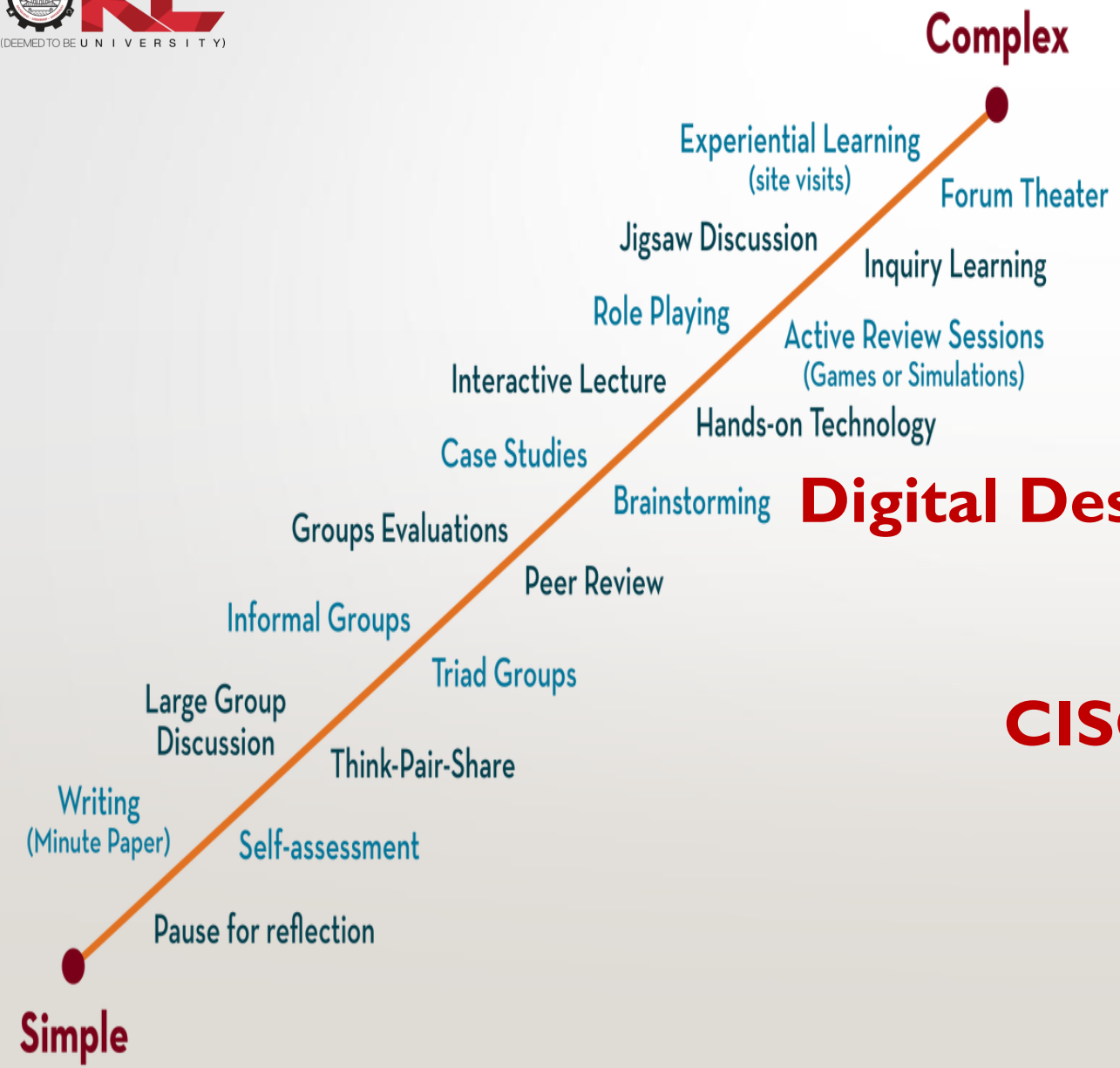


Department of BES-II

Digital Design and Computer Architecture

23EC1202

Topic:

CISC and RISC architectures

Session No: 26

AIM OF THE SESSION

To understand the fundamental differences between CISC and RISC architectures, including their design principles, performance implications, and suitability for various computing applications.

INSTRUCTIONAL OBJECTIVES

This Session is designed to:

1. Learn about the fundamental design differences between CISC and RISC architectures.
2. Understand how the differences in instruction sets affect performance.
3. Learn about the types of applications and environments where each architecture type is most suitable.

LEARNING OUTCOMES

At the end of this session, you should be able to:

1. Gain a clear understanding of the design philosophies behind CISC and RISC.
2. Develop insights into how the choice between CISC and RISC architectures affects performance metrics.
3. Acquire the ability to assess and decide which architecture is more suitable for specific applications

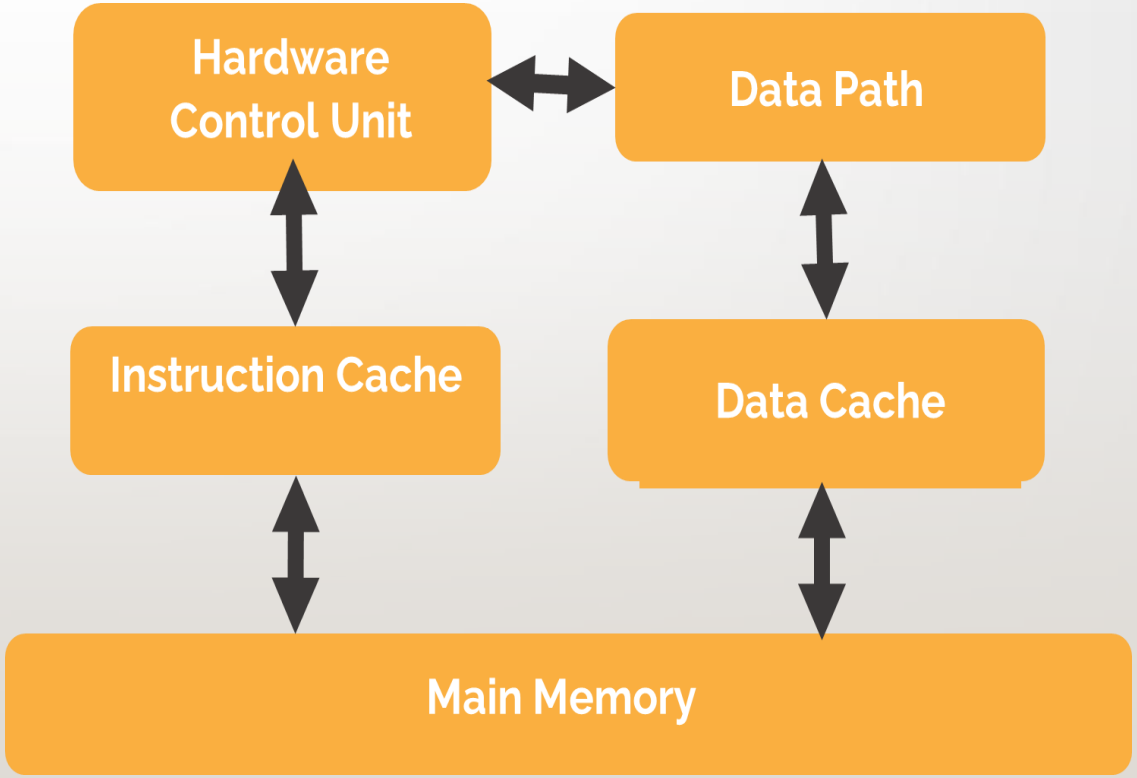
RISC & CISC

- The concepts of RISC (Reduced Instruction Set Computing) and CISC (Complex Instruction Set Computing) represent two fundamental approaches to architecture design.

- These paradigms influence the complexity of microprocessors, how they execute instructions, and their overall performance and efficiency in various computing environments.

Design Philosophy - RISC

- RISC architectures are designed around a small set of simple instructions.
- The goal is to execute instructions at a high speed, with most instructions completing in one clock cycle.
- Emphasizes simplicity and efficiency at the hardware level, allowing for faster instruction execution through pipelining.



Characteristics - RISC

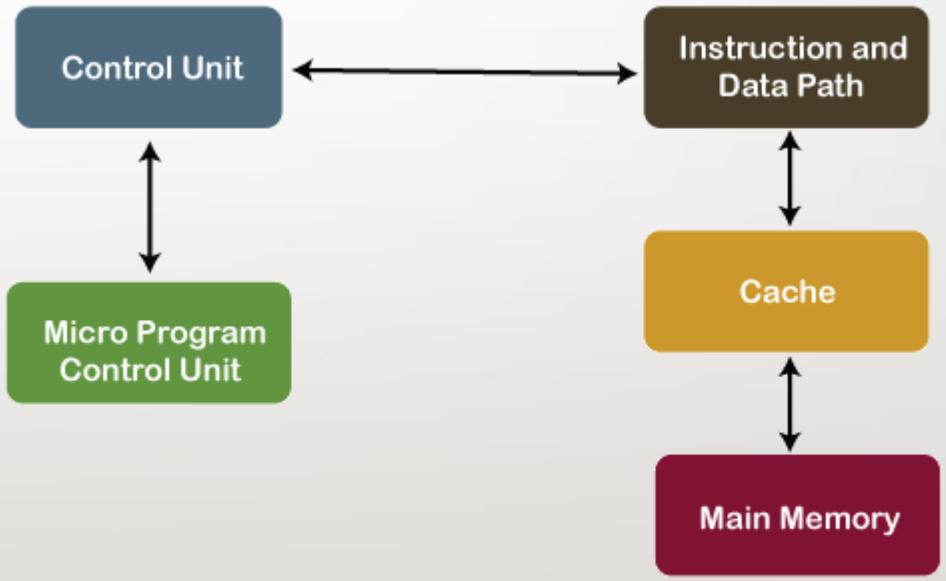
- **Simple Instructions**: RISC instructions are simple and of fixed size, which simplifies fetching and decoding stages in the pipeline.
- **Register-Based Operations**: Operations are typically performed between registers, with a separate load/store instruction for memory access, reducing the complexity of instructions.
- **Fewer Data Types and Addressing Modes**: Focuses on optimizing a smaller set of operations, leading to less complexity in instruction design.

Advantages & Disadvantages - RISC

Advantages	Disadvantages
• Simplified pipelining and efficient execution due to uniform instruction size and format. • Potentially higher performance in applications benefiting from high instruction throughput. • Lower power consumption and heat generation, making it suitable for mobile and embedded systems.	• Requires more instructions for complex operations, which can lead to increased program size. • The compiler has to work harder to optimize instruction usage, putting more emphasis on software design.

Design Philosophy - CISC

- CISC architectures feature a large set of complex instructions.
- Designed to accomplish tasks in fewer lines of code, with instructions capable of performing multiple operations.
- Aims to reduce the software complexity by providing instructions that can execute high-level tasks directly.



CISC Architecture

Characteristics - CISC

- **Complex Instructions**: Variable-length instructions that can carry out multiple operations, such as loading from memory, performing an arithmetic operation, and storing the result back to memory in a single instruction.
- **Memory-to-Memory Operations**: Direct operations on memory without the exclusive need for register operands.
- **Rich Addressing Modes**: Supports a wide variety of addressing modes to access data, increasing flexibility but also the complexity of decoding.

Advantages & Disadvantages - CISC

Advantages	Disadvantages
• Reduced program size due to more expressive instructions, which can lead to better cache utilization. • Potentially less work for compilers as instructions can directly implement high-level constructs.	• Complexity in decoding variable-length instructions can slow down execution and complicate pipelining. • Higher power consumption and heat generation due to the complex nature of the instruction set and execution units.

Application and Impact of RISC & CISC

- **RISC** is widely used in environments where efficiency and performance-per-watt are crucial, such as in mobile devices, tablets, and embedded systems. Its principles are also foundational to the design of many modern microprocessors that emphasize parallel execution and efficiency.
- **CISC** is often found in general-purpose computing, where its wide range of instructions and capabilities can simplify software development. Intel's x86 architecture, prevalent in desktop and server processors, is a well-known example of CISC.

CISC Vs RISC

CISC	RISC
Emphasis on hardware	Emphasis on software
Multiple instruction sizes and formats	Instructions of same set with few formats
Less registers	Uses more registers
More addressing modes	Fewer addressing modes
Extensive use of microprogramming	Complexity in compiler
Instructions take a varying amount of cycle time	Instructions take one cycle time
Pipelining is difficult	Pipelining is easy

SELF-ASSESSMENT QUESTIONS

1. What is a characteristic feature of RISC architecture?

A) Variable-length instructions
B) Complex instructions capable of performing multiple tasks
C) Simple, fixed-length instructions
D) Direct execution of high-level language constructs

2. Which of the following is an advantage of CISC architecture?

A) Reduced program size due to more expressive instructions
B) Lower power consumption and heat generation
C) Faster execution due to simpler decoding
D) Simplified pipelining due to uniform instruction size

SELF-ASSESSMENT QUESTIONS

3. In RISC architecture, where are operations primarily performed?

A) Directly on memory
B) Between registers, with separate load/store instructions for memory
C) Using a stack-based approach
D) Using complex addressing modes

4. Which statement best describes the design philosophy behind CISC architectures?

A) To reduce the software complexity by providing instructions that can execute high-level tasks directly
B) To execute instructions at a high speed, with most instructions completing in one clock cycle
C) To simplify hardware design by minimizing the number of instructions
D) To focus exclusively on optimizing for power efficiency and heat generation

TERMINAL QUESTIONS

Short answer questions:

1. Provide the expansion of RISC and CISC.

Long answer questions:

1. Develop the model of RISC architecture, detailing its design philosophy, key features.
2. Differentiate CISC and RISC architectures in computer organization, discussing their design principles.
3. Develop the model of CISC architecture, detailing its design philosophy, key features.

REFERENCES FOR FURTHER LEARNING OF THE SESSION

Reference Books:

1. Computer Organization by Carl Hamacher, Zvonko Vranesic and Saftwat Zaky.
2. Computer System Architecture by M. Morris Mano
3. Computer Organization and Architecture by William Stallings

Sites and Web links:

1. https://www.geeksforgeeks.org/computer-organization-risc-and-cisc/
2. https://www.javatpoint.com/risc-vs-cisc

THANK YOU

(DEEMED TO BE UNIVERSITY)

Team – Digital Design & Computer Architecture