Computer Organization

Credits: 4

Preconditions:

- Digital Circuits (CSE111)

Post conditions:

The students will be able to:

- Write program in assembly language (MIPS ISA) - compare performance between several implementations of a computer program,
- Analyze processor performance for different implementation strategies: e.g., single vs. multicycle, pipelined vs. nonpipelined execution,
- Simulate and compare performance of cache memory, compare caches with different configuration,
- Analyze basic I/O operation and their performance.

Brief Description:

Introduction to computer systems: General overview of computer abstraction and technology. Instruction set architecture: instruction type, format, operand, addressing mode. Computer arithmetic: addition, subtraction, multiplication and division. Floating point representation. Basics of microprocessor: pipeline, datapath and control. Data and control hazards. Parallelism: Instruction Level Parallelism (ILP). Memory hierarchy: Exploiting locality using cache memory, virtual memory. I/O and storage: performance of disk and file systems.

Lecture Schedule:

Week	Topics Covered	Assgn./Tasks
Week 1	Refreshing sequential circuits, State machine	
Week 2	Performance evaluation of a computer, Amdahl's Law, Use of AM, GM, HM in performance evaluation, Introduction to MIPS ISA	SPEC benchmark installation and benchmarking a desktop
Week 3	MIPS ISA, Instruction types, Register file, Procedure call, stack handling during procedure call. MIPS addressing modes	Install SPIM simulator
Week 4	Computer arithmetic, multiplier and divider implementation, IEEE 754 floating point, Floating point multiplier and divider .	Check a desktop / server for endianness, check IEEE 754 compliance
Week 5	Basics of processor design, Single cycle datapath and control design.	Write MIPS assembly program

Week 6	Single cycle implementation of MIPS, Multicycle implementation, Introduction to pipeline	Write MIPS assembly program
Week 7	Pipeline datapath, Forwarding, Data Hazards, Branch instructions and its Implementation,	Write MIPS program, optimize, estimate cycles required for few different implementation
Week 8	Memory hierarchy, Introduction to cache memory, Impact on performance, cache optimizations	Perform matrix operation, report change in performance for different type of memory access
Week 9	Virtual Memory, page table handling	Install Dinero cache simulator. Use address trace to report performance for different configuration
Week 11	I/O, Storage, Interrupt handling	Experiment with cache simulator
Week 12	Interrupt handling, DMA	
Week 13	Course wrap up	

Tutorials: Weekly tutorial for doubt clearing and problem solving.

Labs: Yes

Attendance: as per institute policy.

Evaluation: as per announcement by the course instructor satisfying

- Midsem Exam: at least 10%
- Final Theory Exam: 20–40%
- Final Exam Components (Lab Exam + Theory Exam): 30-40%
- The remaining percentage is assigned to quizzes, assignments, projects and presentations as specified by the instructor.

Text/Other resources:

1. David Patterson and John Hennessy's Computer Organization and Design: The Hardware Software Interface, Morgan Kaufmann; 4 edition, **ISBN-13:** 978-0123744937