Computer Architecture

Textbooks for reading:

1. David A. Patterson and John L. Hennesy, “Computer Architecture - A Quantitative Approach”, Fourth Edition, ISBN-10: 0-12-370490-1 (ISBN-13: 978-0-12-370490-0), Publisher: Morgan Kaufman Publishers, Inc.

2. Andrew S. Tanenbaum, “Structured Computer Organization”, Fifth Edition, ISBN-10: 0-13-148521-0, Publisher: Prentice Hall.

1. Computer performance metrics

- Execution time
- Clock cycle rate
- Clock cycle time
- MIPS rate
- Instruction count
- Throughput
- Response time
- Benchmark programs
- Amdahl’s Law
- Moor’s Law

2. Processors

2.1 Instruction set architectures

- RISC/CISC designs
- Various types of instructions
- Memory addressing modes
- Performance analysis for the above topics

2.2 Processor architectures

- Stack-based architecture processors
- Register-based architecture processors
- Accumulator architecture processors
- Register-Memory architecture processors
- Register-Register architecture processors
- Memory-memory architecture processors
- Performance analysis for the above topics

2.3 Datapath architectures

- Scalar, super-scalar, pipeline, super-pipeline architectures
- VLIW and vector datapath processors
- Speed-up factor for various datapath architectures
- Impact of deep pipeline processors

- Different types of pipeline hazards
- Hardware and software solutions for various pipeline hazards
- Dynamic and static solutions for various pipeline hazards
- Different types of data dependency
- Different solutions for different data dependency
- Multi-function unit pipelines
- Dynamic branch prediction and speculative executions
- Score-board dynamic instruction scheduling and out-of-order executions
- Performance analysis for the above topics

3. Memory subsystem

3.1 Memory hierarchy

- Concepts
- Performance analysis for the above topics

3.2 Cache memory

- Average memory access latency
- Write-through and write-back cache policy
- Cache associativity
- Impacts from cache misses
- Solutions for cache misses
- Memory interleaving and memory pipelining
- Performance analysis for the above topics

3.3 Virtual Memory

- Concepts of logical and physical address
- Performance analysis for the above topics
- Paging
- Performance analysis for the above topics

3.4 Segmentation

- Concept of segmentation
- Performance analysis for the above topics

4. Bus

4.1 Basic knowledge of bus

- Concept
- Performance analysis

4.2 Types of wires in bus

- Concept
- Different types of I/O device addressing
- Performance analysis

4.3 Internal and external bus

- Concept
- Performance analysis

4.4 Performance metrics in bus

- Concept
- Performance analysis

4.5 Bus arbitrations

- Concept
- Performance analysis

5. I/O Devices

5.1 Different types of I/O devices

5.2 Methods for I/O device accesses

- Programmed I/O's, interrupts, centralized DMA, and cycle-stealing DMA
- Performance analysis

5.3 Queuing theory

- Concept
- Performance analysis

6. Parallel computing

6.1 Different levels of parallel computers

- Instruction-level parallelism
- Thread-level parallelism
- Function-level parallelism
- Process-level parallelism
- Computer-level parallelism
- Performance analysis

6.2 Different models for parallel computing

- SISD
- SIMD and vector-multiplication algorithms
- MISD
- MIMD
- Performance analysis

6.3 Cache consistency issues in parallel computers

- Concept
- MESI cache consistency protocol
- Performance analysis

7. Other topics related to the existing processors
   - Intel’s hyper-threading
   - Intel’s micro-operations
   - Performance analysis