Computer Organization & Architecture
Review

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Chapter 1 (1)

- 知识点1. Computer Types (textbook: 1.1 Computer Types)
  - ☐ Embedded computers
  - ☐ Personal computers
  - ☐ Servers and enterprise systems
  - ☐ Supercomputers and grid computers

Chapter 1 (2)

- 知识点2. Five basic functional units of computers (textbook: 1.2 Functional Units)
    - ☐ Arithmetic and logic unit
    - ☐ Control unit
    - ☐ Memory
    - ☐ Input unit
    - ☐ Output unit

Chapter 1 (3)

- 知识点3. Computer Generations (textbook: 1.7 Historical Perspective)
  - The first generation: vacuum tubes
  - The second generation: transistors
  - The third generation: integrated circuits
  - The fourth generation: LSI&VLSI

Chapter 9 (1)

- 知识点1.Integer Representation (ppt: Integer Representation)
  - ☐ Signed-magnitude
  - ☐ Signed one's complement
  - ☐ Signed two's complement
  - ☐ 掌握程度
    - 给定一个整数，正确转换出原码、反码、补码
    - 给定一个整数和机器码制，确定表示范围。
    - 负数原码和补码互相转换：符号不变，数值部分求反加1
    - 负数原码和反码之间互相转换：符号不变，数值部分求反。
    - 负数原码转换成真值
    - 负数补码转换成真值

Chapter 9 (2)

- 知识点2.Addition and Subtraction of Signed Numbers (textbook: 9.1)
  - ☐ Addition Rule
  - ☐ Subtraction Rule
  - ☐ Arithmetic Overflow
  - ☐ Twos Complement Operation
  - ☐ 掌握程度
    - 怎样判别溢出（公式）
    - 给定两个带符号整数，正确计算出两个数的和，并判断是否溢出。
    - 给定两个带符号整数，正确计算出两个数的差，并判断是否溢出。

Chapter 9 (3)

- 知识点3.Ripple Carry Adder (textbook: 9.1)
  - □ 1-bit full adder
  - □ n-bit ripple-carry adder
  - □ Hierarchical adder
  - □ 掌握程度
    - 能够写出1位全加器中和与进位输出的逻辑表达式，并画出逻辑图。
    - 掌握n位行波进位加法器的原理。
    - 给定一个位数较少的加法器，掌握用来构造较多位数加法器的方法。
    - 半加器

Chapter 9 (4)

- 知识点4. Gate Delays(textbook: 9.1)
  - Delay analysis of n-bit ripple-carry adder
  - 掌握程度
    - 给定位数的行波进位加法器，能够分析各位和以及进位的时间延迟

Chapter 9 (5)

- 知识点5. Carry-lookahead adder(textbook: 9.2)
  - □ Logic function of Gi and Pi
  - □ Figure of Bit-Stage cell (Figure 9.4(a))
  - □ Logic function of 4-bit carry-lookahead adder
  - □ Figure of 4-bit carry-lookahead adder(Figure 9.4(b))
  - □ Delay analysis of n-bit carry-lookahead adder
  - □ Delay analysis of n-bit ripple-carry adder
  - □ 掌握程度
    - 熟练写出Gi和Pi的逻辑表达式
    - 能够画出bit-stage cell的逻辑框图
    - 熟练写出4位先行进位加法器中各进位的表达式
    - 能够画出4位先行进位加法器的逻辑框图
    - 掌握理论上n位先行进位加法器中和与进位的时间延迟

Chapter 9 (6)

- 知识点6. Hierarchical Adder Design (ppt: carry-lookahead adder)
  - 掌握程度
    - 能够用较少位数的先行进位加法器构造更多位数的加法器并分析出各位和与进位的时间延迟

Chapter 9 (7)

- 知识点7. Sequential Multiplier (textbook: 9.3)
  - 掌握程度
    - 给定两个整数，能够用机器算法计算出结果，写出整个计算步骤。具体例子参考Figure9.7。

Chapter 9 (8)

- 知识点8. Booth Algorithm (textbook: 9.4)
  - Recoding of multiplier
  - Using recoded multiplier to multiply
  - 掌握程度
    - 使用布斯算法熟练转换乘数
    - 使用手工算法将转换后的乘数与被乘数相乘

Chapter 9 (9)

- 知识点9. Integer division(textbook: 9.6)
  - Nonrestoring division
  - 掌握程度
    - 给定被除数和除数，使用不恢复余数除法，能够用机器算法计算出结果，写出整个计算步骤。具体例子参考Figure9.25。

Chapter 9 (10)

- 知识点10. Floating-point representation (textbook: 9.7)
    - $(-1)^S \times M \times 2^e$
    - IEEE 754 Standard
        - Single Precision
        - Double Precision
        - Four Special Values
    - 掌握程度
        - 给定一个十进制小数，熟练转换成给定浮点格式的浮点数
        - 给定一个机器数表示的单精度/双精度浮点数，熟练转换成十进制数
        - IEEE单精度浮点数表示方法和表示范围
        - IEEE双精度浮点数表示方法和表示范围

Chapter 9 (11)

- 知识点11. Floating-point Arithmetic Operation (textbook: 9.7)
    - □ Addition
    - □ Subtraction
    - □ Multiplication
    - □ Division
    - □ 掌握程度
        - 给定两个浮点数，根据加减运算规则或乘除运算规则计算出结果
        - 重点放在加减法

Chapter 8 (1)

- 知识点1. Basic concepts of memory (ppt: basic concepts)
  - Word
  - Word length
  - Address
  - Address space
  - Byte addressable memory
  - Byte ordering: big-endian, little-endian
  - Read and write operation of main memory
  - Physical types of memory: semiconductor, magnetic surface, optical
  - Main memory capacity
  - Unit of transfer: internal memory, external memory
  - Access methods: sequential, random, direct access
  - Performance: memory access time, memory cycle time
  - Physical characteristic: volatile/nonvolatile, erasable/nonerasable

Chapter 8 (2)

- 知识点2. Static RAM (textbook: 8.2)
  - SRAM Chip
  - 掌握程度
    - 理解半导体存储器读写操作原理
    - 掌握SRAM芯片的外部引脚

Chapter 8 (3)

- 知识点3. Dynamic RAM (textbook: 8.2)
  - DRAM cell
  - DRAM Refresh
  - DRAM Chip
  - SDRAM
  - Burst Operation
  - Latency
  - Bandwidth
  - DDR&SDRAM
  - 掌握程度
    - 掌握DRAM芯片的外部引脚
    - 理解Burst操作
    - 掌握Latency和Bandwidth概念
    - 知道什么是DDR和SDRAM

Chapter 8 (4)

- 知识点4. Structure of Larger Memory (ppt: structure of larger memory)

☐ Static Memory Systems

- 位扩展法
- 字扩展法
- 字位同时扩展法

☐ 掌握程度

- 使用指定的芯片构造大容量存储器，能够分析出使用多少片芯片，画出芯片排列情况，译码器、数据线、地址线、片选线连接正确。

- 会计算地址范围，如课本8.10中，所构造出的2M×32的存储器地址范围为000000H-1FFFFFH。

Chapter 8 (5)

- 知识点5. Memory Hierarchy (ppt: Memory Hierarchy)

  □ Why does a computer have memory hierarchy?

  □ What is memory hierarchy? Figure8.14

  □ Principle: locality of reference

  - Temporal Locality
  - Spatial Locality

  □ 掌握程度

  - 理解为什么需要存储器层次结构
  - 掌握存储器层次结构图8.14
  - 理解程序访问的局部性原理（时间局部性、空间局部性）

Chapter 8 (6)

- 知识点6. Cache Principle and Policy (textbook: 8.6)
  - Purpose of Cache
  - Principle of Cache
  - Cache Read Operation
  - Load Through/Early Restart Policy
  - Valid Bit
  - Hit and Miss
  - Replacement Policy
    - LRU
    - Random
  - Write Policy
  - Dirty Bit
  - Cache Capacity

Chapter 8 (7)

- 知识点7. Cache Mapping Schemes (ppt: cache mapping schemes)
  - ☐ Direct Mapping
  - ☐ Associative Mapping
  - ☐ Set Associative Mapping
  - ☐ 掌握程度
    - 掌握Direct Mapping的映射函数，使用主存地址访问cache的方法，熟练地将主存地址划分成fields，此种映射方式的优缺点。
    - 掌握Associative Mapping的映射方法，使用主存地址访问cache的方法，熟练地将主存地址划分成fields，此种映射方式的优缺点。
    - 掌握Set Associative Mapping的映射函数，使用主存地址访问cache的方法，熟练地将主存地址划分成fields，此种映射方式的优缺点。
    - 会使用三种映射方式解决实际问题。

Chapter 8 (8)

- 知识点8. Multilevel Cache (ppt: Multilevel cache)

  - Hit rate

  - Miss penalty

  - Average access time of single-level cache

    tavg=hC+(1 − h)M

  - Average access time of two-level cache

  $$t_{avg} = h_1 C_1 + (1 - h_1)(h_2 C_2 + (1 - h_2)M)$$

Chapter 8 (9)

- 知识点9. Virtual Memory
  - 了解Motivations of VM
  - 掌握What is VM

Chapter 8 (10)

- 知识点10. Virtual Memory
  - 掌握Address Translation
  - 理解Page hit and Page fault
  - 理解TLB的用途
  - 理解Page table and page table entry
  - 了解Page replacement
  - 理解Write policy
  - 理解Internal fragmentation
  - 掌握Page size
    - Smaller vs. bigger

Chapter 8 (11)

- 知识点11. Magnetic Hard Disk (ppt: Secondary Storage)
  - 会计算Capacity
  - Data Organization
    - Track
    - Sector
  - Access Time
    - Seek time
    - Rotational delay
  - 理解Cylinder概念

Chapter 2 (1)

- 知识点1. Instruction Format (ppt: Instruction Format)
  - What is Instruction Set?
  - Elements of An Instruction
  - Instruction Length
  - Address Field Format
    - Zero-address
    - One-address
    - Two-address
    - Three-address
  - Opcode Field Format (Expanding Opcode)
    - 熟练掌握用扩展操作码方法设计指令格式

Chapter 2 (2)

- 知识点2. Addressing Modes (ppt: Addressing Modes)
  - □ What is addressing modes?
  - □ Typical Addressing Modes
    - Immediate
    - Absolute
    - Indirect (CISC)
    - Register
    - Register indirect
    - Index mode and variation
  - □ 掌握程度
    - 针对每种寻址方式，掌握该种方式的操作数存放位置，有效地址如何计算，优缺点。

Chapter 2 (3)

- 知识点3. RISC & CISC (textbook: 2.10,2.11)
  - CISC Addressing Modes
    - Autoincrement Mode
    - Autodecrement Mode
    - Relative Mode
  - Condition Code
    - N
    - Z
    - C
    - V
  - RISC Characteristics
  - CISC Characteristics

Chapter 5 (1)

- 知识点1. Execution steps of an instruction (textbook: 5.4,5.5)
  - 掌握程度
    - 理解图5.8的数据通路
    - 给出数据通路图，能够写出Add、Load、Store、Branch、Subroutine Call指令的执行步骤。
    - 记住图5.12的指令格式。
    - 结合图5.18，理解指令执行过程中各步骤需要的控制信号。

Chapter 5 (2)

- 知识点2. Hardwired Control Unit(textbook: 5.6)
  - 掌握程度
    - 会画课本图5.21，并描述原理。

Chapter 5 (3)

- 知识点3. Microprogram Control Unit(ppt: CISC-style Processors)
  - ☐ Principle of microprogram control: Figure 5.27
  - ☐ Terminologies
    - Control word : A control word is a word whose individual bits represent the various
    - Microprogram: A sequence of CWs corresponding to the control sequence of a machine instruction constitute the microroutine for that instruction.
    - Control store: The microinstruction for all instructions in the instruction set of a computer are stored in a special memory called control store.
    - 掌握程度
      - ☐ 理解概念，会画课本图5.27，并描述原理。

Chapter 6 (1)

- 知识点1. Basic Concept of Pipeline (ppt: Basic Concepts and Pipeline Organization)
  - What is pipelining?
  - Principle of pipeline
  - Pipeline terminology
    - Pipeline stage
    - Pipeline depth
    - Pipeline latency
    - Pipeline throughput
  - 掌握程度
    - 理解概念
    - 掌握流水线的原理

Chapter 6 (2)

- 知识点2. Pipeline Issues (ppt: Pipeline Issues and Data Dependencies)
  - Data Hazard
  - Instruction Hazard or Control Hazard
  - Structural Hazard
  - 掌握程度
    - 理解并记住三种hazard的定义
    - 掌握引起三种hazard的原因

Chapter 6 (3)

- 知识点3. Data Dependencies (ppt: Pipeline Issues and Data Dependencies)
  - 掌握程度
    - 定义
    - 解决方法
      - Operand Forwarding (注意并不是所有的 data hazard都能够用此方法解决）

Chapter 3 (1)

- 知识点1. I/O Interface (ppt: I/O Interface)
  - Constituents of I/O Interface
    - Address decoder
    - Data Register
    - Status Register
    - Control Register
    - Control Circuitry
  - Addressing mode of I/O Interface
    - Memory-mapped I/O
    - Isolated I/O

Chapter 3 (2)

- 知识点2. Program Controlled I/O (ppt: Program Controlled I/O)
  - ☐ Principle
  - ☐ Advantage and disadvantage

Chapter 3 (3)

- 知识点3. Interrupt concepts and processing (ppt: Interrupt concept and processing)
  - 掌握What is interrupt?
  - 掌握Advantages of interrupt-driven I/O
  - 理解Concepts of Interrupt
    - Interrupt request
    - Interrupt acknowledge
    - Interrupt handler
    - Interrupt latency

Chapter 3 (4)

- 知识点3. Interrupt concepts and processing (ppt: Interrupt concept and processing) (ctd.)
  - Difference between subroutine and interrupt-service routine
  - 能够描述Interrupt processing (flowchart)
  - Enabling and disabling interrupt
    - At processor end
    - At device end

Chapter 3 (5)

- 知识点4. Multiple device interrupt system Design Issues (ppt: Multiple device interrupt system Design Issues)
  - ☐ Identify Interrupt Source
    - ■ Polling (Non-vectored Interrupt)
    - ■ Vectored Interrupt
  - ☐ Multiple-level Interrupt (Interrupt Nesting)
  - ☐ Simultaneous Interrupt
    - ■ Software polling
    - ■ Daisy chain

Chapter 3 (6)

- 知识点5. DMA (ppt: DMA)
  - 理解DMA Operation的三个步骤
  - 掌握Registers in a DMA Controller
    - Data register
    - Count register
    - Address register
    - Control register
  - 理解DMA的三种数据传输方式
    - Burst
    - Cycle stealing
    - Transparent

Summary

- 需要复习的内容
    - 前面总结的知识点
    - 作业习题
    - 课件上的exercise