CDA 3103 Computer Organization Module 6 Assignment

Part I: Problems

1. [20 points] Suppose a computer has bytes of byte-addressable main memory and a cache size of bytes, and each cache block contains 64 bytes.
2. How many blocks of main memory are there? ( **226 Blocks** )
3. How many blocks of cache memory are there? ( **29 Blocks** )
4. If this cache is direct-mapped, what is the format of a memory address as seen by the cache; that is, the size of the tag field **17** , the size of block field **9** , and the size of the offset field **6** .
5. If this cache is fully associative, what is the format of a memory address as seen by the cache; that is, the size of the tag field **26**  , and the size of the offset field **6**  .
6. If this cache is 4-way set associative, what is the format of a memory address as seen by the cache; that is, the size of the tag field **19** , the size of set field **7** , and the size of the offset field  **6**  .
7. [24 points] Suppose we have a memory and a direct-mapped cache with the following characteristics.

* Memory is byte addressable
* Memory addresses are 16 bits
* The cache has 8 blocks
* Each cache block holds 16 bytes of data

1. [6 points] In the spaces below, indicate how the 16 address bits are allocated to the offset, index, and tag parts of the address used to reference the cache: **4**  .offset bits **3** tag bits **9** index bits.
2. [12 points] Below is a sequence of four binary memory addresses in the order they are used to reference memory. Assume that the cache is initially empty. For each reference, write down the tag and index bits and circle either hit or miss to indicate whether that reference is a hit or a miss.

|  |  |  |  |
| --- | --- | --- | --- |
| Memory address | Tag | Index | Hit / Miss (circle) |
| 0010 1101 1011 0011 | **0010 1101 1** | **011** | **Miss** |
| 0000 0110 1111 1100 | **0000 0110 1** | **111** | **Miss** |
| 0010 1101 1011 1000 | **0010 1101 1** | **011** | **Hit** |
| 1010 1010 1010 1011 | **1010 1010 1** | **010** | **Miss** |

1. [6 points] Suppose the cache access time is 15ns, main memory access time is 220ns, and the cache hit rate is 95%. Assuming non-overlapped access, what is the average access time for the processor to access an item?

**(.95)(15ns) +(.05)(220ns + 15ns)**

1. [20 points] Assuming a cache of 4096 blocks, a four-word block size, each word contains 4 bytes, and a 64-bits memory address. Memory is byte addressable, and random block replacement policy and write back policy are implemented. Find the total number of tag bits for caches that are
   * 1. direct-mapped

**Tap = 48 bit**

* + 1. 2-way set associative

**Tag = 49 bit**

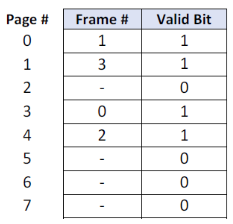
* + 1. 4-way set associative

**Tag = 50 bit**

* + 1. Fully associative

**Tag = 60 bit**

1. [30 points] Suppose you have a byte-addressable virtual address memory system with 8 virtual pages of 64 bytes each, and 4 page frames. Assuming the following page table, answer the questions below:



1. [2 points] How many bits are in a virtual address?

**9 bits**

1. [2 points] How many bits are in a physical address?

**8 bits**

1. [2 points] How many bits are virtual page number?

**3 bits**

1. [2 points] How many bits are page frame number?

**2 bits**

1. [2 points] How many bits are page offset?

**6 bits**

1. [20 points] What physical address corresponds to the following virtual addresses (if the address causes a page fault, simply indicate this is the case)?
   1. 0x00

**01 00 0000, Hit**

* 1. 0x44

**11 00 0100, Hit**

* 1. 0xC2

**00 00 0010, Hit**

* 1. 0x80

**Page fault.**

1. [6 points] Suppose we have 210 bytes of virtual memory and 28 bytes of physical main memory. Suppose the page size is 24 bytes.
   1. [2 points] How many pages are there in virtual memory?

**26 pages**

* 1. [2 points] How many page frames are there in main memory?

**24 pages**

* 1. [2 points] How many entries are in the page table for a process that uses all of virtual memory?

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Part II: Submission Requirements

The following requirements are for electronic submission via Canvas.

* Your solutions must be in a single file with a file name yourname-module6-assignment.
* Upload the file by following the link where you download the homework description on Canvas.
* If scanned from hand-written copies, then the writing must be legible, or loss of credits may occur.
* Only submissions via the link on Canvas where this description is downloaded are graded. Submissions to any other locations on Canvas will be ignored.