**Mid-1/Marks=30/Time: 1 Hour**

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| 1. | Consider a computer with the following characteristics: total of 1Mbyte of main memory;  Content of each addressable location is 1 byte; block size of 16 bytes; and cache size of 64 Kbytes.  (a) For the main memory addresses of FA010, B1234, and CAB0E, give the corresponding tag, cache line address, and word offsets for a direct-mapped cache.  (b) Give any two main memory addresses with different tags that map to the same cache slot for a direct-mapped cache.  **(c)** For the main memory addresses of FA010 and CA1BE, give the corresponding tag and offset values for a fully-associative cache.  **(d)** For the main memory addresses of FA010 and CA1BE, find the corresponding cache sets in case of a two-way set-associative mapping. | 8 |
| 2. | 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 32 lines and each cache line holds 4 bytes of data  (ii) What is the ratio between total bits required for such a cache implementation over the data storage bits?  (iii) Below is a sequence of binary memory addresses in the order they are used to reference memory. Assume that the cache is initially empty. For each reference, indicate whether that reference is a hit or a miss.   |  |  |  | | --- | --- | --- | | Memory address | Hit/Miss | Calculate | | 0010 1101 1011 0001 |  | Hit ratio = | | 0010 1101 1011 0010 |  | | 0011 1101 1011 0001 |  | | 0010 1101 1011 0010 |  | | 0010 1111 1011 0000 |  | | 0010 1111 1011 0001 |  | |  |  |  | | 4+6 |
| 3. | A fully associative mapped cache has 16 lines with 8 bytes per line. The size of the main memory is 216 bytes and cache is initially empty. Compute the hit ratio of a program that executes from memory locations 20 – 45, then loops two times from memory locations 28 – 45 before halting. Use FIFO replacement algorithm. | 10 |
| 4. | A 64KB four-way set-associative cache is byte-addressable and contains 32B lines. Memory addresses are 32 bits wide. Show Five main memory block addresses those are mapped to set number 5? | 2 |