CSc 256 Chapter 9 Assignment

PDF or MSWord .docx files due on iLearn Monday 12/12/2016, 5pm
(no late submissions; 6% of your grade)

This is an individual project. Work on your own. All submissions *must* be typed. Submit via the iLearn submission link. [Both Word docx and pdf versions of this document available at iLearn.]

Problem 1:

Suppose we have a 8KB direct-mapped data cache with 4-byte blocks.

a) Show how a 32-bit memory address is divided into tag, index and offset. Show clearly how many bits are in each field. (10 points)

ANS:
8KB / 4B = 2048 blocks
offset = log_2 (4) = 2 bits
index = log_2 (2048 blocks) = 11 bits
tag = 32 - index (11) - offset (2) = 19 bits

b) How many total bits are there in this cache? (15 points)

ANS:

total bits = (32 + bits in tag + 1 (for valid bit)) * # of blocks
total bits = (32 + 19 + 1) * 2K
= 52 * 2K
= 104 Kb [= 106496 bits]

c) Consider this address trace:

0x404c4958
0x404c46d8
0x404c4944
0x404c86d8
0x40544944
0x404c4958
0x404c86d8
0x404c4970

For this cache, for each address in the above trace, show the tag, index and offset in binary. Indicate whether each reference is a hit or a miss. What is the miss rate? (20 points)

ANS:

address	tag	index	offset	Hit/miss
0x404c4958	0100 0000 0100 1100 010	0 1001 0101 10	00	miss
0x404c46d8	0100 0000 0100 1100 010	0 0110 1101 10	00	miss
0x404c4944	0100 0000 0100 1100 010	0 1001 0100 01	00	miss
0x404c86d8	0100 0000 0100 1100 100	0 0110 1101 10	00	miss
0x40544944	0100 0000 0101 0100 010	0 1001 0100 01	00	miss
0x404c4958	0100 0000 0100 1100 010	0 1001 0101 10	00	hit
0x404c86d8	0100 0000 0100 1100 100	0 0110 1101 10	00	hit
0x404c4970	0100 0000 0100 1100 010	0 1001 0111 00	00	miss

miss rate = 6 / 8 = 75%

Problem 2:

Suppose we have a 8KB direct-mapped data cache with 64-byte blocks.

a) Show how a 32-bit memory address is divided into tag, index and offset. Show clearly how many bits are in each field. (10 points)

ANS: # of blocks = 8K / 64 = 256 blocks
offset = log_2 (64) = 6 bits
index = log_2 (256) = 8 bits
tag = 32 - 8 - 6 = 18 bits

b) How many total bits are there in this cache? (15 points)

ANS: (32 + 18 + 1) * (1/4)K
= 51 * (1/4)K
= (51/4)K = 13,056 bits

c) For this cache, for each address in the trace in Problem 1c, show the tag, index and offset in binary. Indicate whether each reference is a hit or a miss. What is the miss rate? (15 points)

ANS:

address	tag	index	offset	Hit/miss
0x404c4958	0100 0000 0100 1100 01	00 1001 01	01 1000	miss
0x404c46d8	0100 0000 0100 1100 01	00 0110 11	01 1000	miss
0x404c4944	0100 0000 0100 1100 01	00 1001 01	00 0100	hit
0x404c86d8	0100 0000 0100 1100 10	00 0110 11	01 1000	miss
0x40544944	0100 0000 0101 0100 01	00 1001 01	00 0100	miss
0x404c4958	0100 0000 0100 1100 01	00 1001 01	01 1000	miss
0x404c86d8	0100 0000 0100 1100 10	00 0110 11	01 1000	hit
0x404c4970	0100 0000 0100 1100 01	00 1001 01	11 0000	hit

miss rate = 5 / 8 = 62.5%

Problem 3 (15 points):

We are comparing the two caches in Problem 1 and Problem 2. Suppose the cache in Problem 1 has a hit time of 1 cycle; the one in Problem 2 has a hit time of 2 cycles. The miss penalty for both is 50 cycles. Calculate the total time taken (in cycles) for all accesses, for each cache.

ANS: Problem 1:
6 misses, 2 hits
6 * (50 + 1) + 2 * 1 = 308
cycles

Problem 2:
5 misses, 3 hits
5 * (50 + 2) + 3 * 2
= 5 * 52 + 6 = 266 cycles