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 printouts in class.

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:

offset: log(4) = 2 bits
blocks = 8K/4 = 2K
index: 11 bits
tag: 32 – 11 – 2 = 19 bits

address = tag ‖ index ‖ offset

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

ANS:

Each block has 1 valid bit, 19-bit tag, 32-bit data
Total bits = 2048 * (1+19+32) = 106496

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	
0x404c4958				
	0100 0000 0100 1100 010	0 1001 0101 10	00	m
0x404c46d8				
	0100 0000 0100 1100 010	0 0110 1101 10	00	m
0x404c4944				
	0100 0000 0100 1100 010	0 1001 0100 01	00	m
0x404c86d8				
	0100 0000 0100 1100 100	0 0110 1101 10	00	m
0x40544944				
	0100 0000 0101 0100 010	0 1001 0100 01	00	m
0x404c4958				
	0100 0000 0100 1100 010	0 1001 0101 10	00	h
0x404c86d8				
	0100 0000 0100 1100 100	0 0110 1101 10	00	h
0x404c4970				
	0100 0000 0100 1100 010	0 1001 0111 00	00	m

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:

offset: 6 bits
blocks = 8K/64 = 128
index: 7 bits
tag: 32 – 7 – 6 = 19 bits

address = tag || index || offset

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

ANS:

each block has 1 valid bit + 19 tag bits + 64*8 data bits
Total bits = 128 * 532 = 68096

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	
0x404c4958				
	0100 0000 0100 1100 010	0 1001 01	011000	m
0x404c46d8				
	0100 0000 0100 1100 010	0 0110 11	011000	m
0x404c4944				
	0100 0000 0100 1100 010	0 1001 01	000100	h
0x404c86d8				
	0100 0000 0100 1100 100	0 0110 11	011000	m
0x40544944				
	0100 0000 0101 0100 010	0 1001 01	000100	m
0x404c4958				
	0100 0000 0100 1100 010	0 1001 01	011000	m
0x404c86d8				
	0100 0000 0100 1100 100	0 0110 11	011000	h
0x404c4970				
	0100 0000 0100 1100 010	0 1001 01	110000	h

miss rate = 5 / 8 = .625

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:

Cache 1 time taken = 2 * 1 + 6 * (1+50) cycles
Cache 2 time taken = 3 * 2 + 5 * (2+50) cycles