

## Problem Set #4

**Date Assigned:** Friday, April 1, 2016

**Date Due:** Friday, April 8, 2016

**Points:** 50 pts

Consider the following byte-addressable memory with 256 bytes where a memory dump yields the following:

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	6d	8d	04	49	e1	a7	1a	f1	0c	8e	12	15	04	87	85	0d
1	72	9e	05	41	e8	83	4d	f4	f8	5e	18	55	bb	69	06	11
2	96	5a	08	18	3b	35	ed	2b	52	d4	d9	54	ae	b7	49	f8
3	a4	96	75	b9	88	42	89	70	f2	58	1e	18	74	7b	64	33
4	ac	d0	43	e1	2c	85	5f	f6	2e	92	22	ab	bf	6e	d0	6a
5	0d	dd	56	45	89	9a	fd	da	32	7a	17	e5	fe	d1	c1	29
6	7a	9f	44	cc	16	2f	84	f0	7b	c3	fe	a7	0c	61	2c	87
7	59	f1	79	11	61	6d	73	23	4b	d3	6b	90	a3	11	44	24
8	6f	b4	cd	0a	23	82	9c	46	df	a6	02	53	d8	e7	6b	a7
9	c6	1c	f2	72	3e	fc	56	65	cd	e0	8e	f2	31	37	1e	e6
A	72	1f	52	cd	63	07	1d	c5	2d	10	83	48	d9	48	d4	0c
B	e0	5a	d7	d6	ff	cb	87	b6	14	2f	f4	77	2a	da	6f	15
C	78	9a	03	da	e9	96	f2	c4	04	84	0f	5b	f9	68	75	5f
D	44	ee	e6	f6	df	12	2c	b5	7c	aa	c1	01	52	02	84	d2
E	d4	fd	2a	df	78	2f	21	d9	ba	92	5e	7f	55	65	54	c5
F	f0	a9	68	e7	0a	f0	10	3c	e6	ac	d9	e9	5d	da	26	7a

Each memory cell address is determined by its row and column, so for instance, the value at address 0xA3 is 0xcd.

The system that produced this memory dump has a cache that contains 4 lines, where each line contains 8 bytes.

Assume that the following sequence of memory accesses take place: 0x2C, 0x6D, 0x86, 0x29, 0xA5, 0x82, 0xA7, 0x68, 0xA0, and 0x2B.

Answer each of the following questions:

1. (8 pts) Assuming a direct mapped cache:
  - a. Show the format for a main memory address.
  - b. What does the cache look like after the 10 memory accesses have been made? Draw the cache showing the contents of the cache including the tags. Your drawing should look like the right hand side of figure 4.10.
  - c. What is the hit rate for this cache on the given sequence of memory accesses? The hit rate is the percentage of accesses that were found in the cache.

2. (8 pts) Assuming a fully associative cache:
  - a. Show the format for a main memory address.
  - b. What does the cache look like after the 10 memory accesses have been made assuming the data are loaded into the cache in the first available location and a FIFO replacement strategy is used. Draw the cache showing the contents of the cache including the tags. Your drawing should look like the right hand side of figure 4.12.
  - c. What is the hit rate for this cache on the given sequence of memory accesses?
  
3. (11 pts) Assuming a 2-way set associative cache:
  - a. Show the format for a main memory address.
  - b. What does the cache look like after the 10 memory accesses have been made assuming an LRU replacement strategy? Draw the cache showing the contents of the cache including the tags. Your drawing should look like the right hand side of figure 4.15.
  - c. What is the hit rate for this cache on the given sequence of memory accesses?
  - d. If a cache hit retrieves a value in 5ns and a main memory access requires 25 ns, what is the average effective access time for this cache assuming that all memory accesses exhibit the same hit rate as the sequence of the 10 given?
  
4. (6 pts) Add the two 8-bit contents at memory locations 0xE0 and 0xF0.
  - a. What is the decimal value of the result if you interpret it as an unsigned integer number? Did an overflow occur? Explain.
  - b. What is the decimal value of the result if you interpret it as a signed two's complement number. Did an overflow occur? Explain.
  
5. (6 pts) Subtract the 8-bit content at memory location 0xE0 from the 8-bit content at memory location 0xF0
  - a. What is the decimal value of the result if you interpret it as an unsigned integer number?
  - b. What is the decimal value of the result if you interpret it as a signed two's complement number.
  - c. What are the values of the carry and overflow flags?
  
6. (11 pts) Use the Booth algorithm to multiply the contents of 0x84 and 0x5F.
  - a. Show all steps using a table similar to the one in Figure 10.13.
  - b. Write down the result of the multiplication in both binary and hex.

**How to turn in your solution:**

- Please make sure your problem sets are typed, answered in order, and stapled together. Name your word document 04punet.docx then submit it into the CS 430 drop folder on Grace.
- A hard copy of your Problem Set Solution is due on the instructor's desk by 9:15am on the day the assignment is due.