Homework 3 Solution

Q1) Cache and Memory (6 points)

1. Direct Mapping

   1) Tag:10, row: 6, offset: 5
   Grading guide: correct: 1; incorrect: 0.5; no answer: 0

   2) 0x 123A63= 1 0010 0011 1010 0110 0011
   Tag = 0x247, line = 0x13, offset = 0x3.

   Grading guide: correct: 1; incorrect: 0.5; no answer: 0

2. Fully associative mapping

   1) Tag:16, offset: 5
   Grading guide: correct: 1; incorrect: 0.5; no answer: 0

   2) 0x 123A63= 1 0010 0011 1010 0110 0011

   Tag = 0x91D3, offset = 0x3

   Grading guide: correct: 1; incorrect: 0.5; no answer: 0

3. 4-way set associative mapping

   1) Tag:12, set: 4, offset: 5

   Grading guide: correct: 1; incorrect: 0.5; no answer: 0

   2) 0x 123A63= 1 0010 0011 1010 0110 0011

   Tag = 0x91D, set = 0x3, offset = 0x3.

   Grading guide: correct: 1; incorrect: 0.5; no answer: 0

Q2) Cache hit and miss (3 points)

Memory 256 byte = 2^8 byte

Direct-mapped cache: 2^4, 4 bytes per block (offset is 2)

Tag: 4, Row: 2, Offset: 2

1.

Grading guide: correct: 1; incorrect with work: 0.5; no answer: 0.
There are 14 accesses total. So, hit ratio is 5/14 ~ 35.7%

Address	Hit or Miss
91	Miss, brought into bock0 with tag 1001
A8	Miss, brought into bock2 with tag 1010
A9	hit
AB	hit
AD	Miss, brought into bock3 with tag 1010
93	Hit
6E	Miss, brought into bock3 with tag 0110
B9	Miss, brought into bock2 with tag 1011
17	Hit
E2	Miss, brought into bock0 with tag 1110
4E	Miss, brought into bock3 with tag 0100
4F	Hit
50	Miss, brought into bock0 with tag 0101
A4	Miss, brought into bock1 with tag 1010

2.
Grading guide: correct: 2; each incorrect tag value: -0.5; no answer: 0

Tag (binary)	Block #	offset 0	offset 1	offset 2	offset 3
0101	0	50	51	52	53
1010	1	A4	A5	A6	A7
1011	2	B8	B9	BA	BB
0100	3	4C	4D	4E	4F

Q3) Virtual memory and cache (6 points)

1. Split the bits for virtual address and physical address

Virtual address

Page = 3	Offset = 15

Physical address

Page = 2	Offset = 15

Grading guide: all correct: 1; incorrect: 0.5; no answer: 0.

2. Split the bits in memory address based on the cache.

Tag = 6	Row =3	Offset = 8

Grading guide: all correct: 1; incorrect: 0.5; no answer: 0.

3.

1) It is a page fault. Virtual page 6 does not have a valid frame in the page table.
Grading guide: correct 1, incorrect or no answer: 0

2) 0x32764 = 11 0010 0111 0110 0100 in virtual address. Since the first three bits are the page number, the page number of %110 = $6.

Page Table

Virtual page #	Physical page #	Valid
0	2	1
1	-	-
2		
3		
4	0	1
5	3	1
6	1	1
7		

Mem LRU stack
6
0
5
4

TLB	Virtual page #	Physical page #	Valid
	6	1	1
	0	2	1

TLB LRU stack

6
0

Grading guide: In this question, there are four tables to update (written in read). For each table's update, correct: 0.5; anything incorrect: 0.

3) Then the virtual page 6 can be converted to physical frame #1
Then 0x32764 = 11 0010 0111 0110 0100 is converted to 01 010 0111 0110 0100 in physical memory, we can split it for cache map. Remember that,
Offset = 8, Row = 3 (number of blocks in a cache is $8=2^3$), then the tag bit is 6.

Tag = 6	Row =3	Offset = 8

Then the address maps to tag 01 0100, row number 111, and offset 0110 0100. That is, in the cache, the refill line number 7 is replaced with this new address, which has a tag 14.

Cache

Line #	Tag	Data
0	10	*
1	0A	*
2	3C	*
3	14	*
4	28	*
5	04	*
6	37	*
7	14	*

Grading guide: correct: 1; incorrect: 0.5; no answer 0.