CSE 451/851 Assignment #5

Assigned: Nov 27, 2023

Notes:

- There are **Three** questions in this homework + 1 Bonus.
- Submit your response to Canvas.
- Latex or Word-based submissions are required for written questions. **Scanned handwritten submissions will not accepted.**
- Please answer each question in detail.

1. [20 points] The system has a TLB cache that is a 2-way set associative with a 4-byte line and 16 total entries. The address is 12 bits length. The current content of the cache appears below:

2-way Set Associative Cache												
Set Index	Way 0						Way 1					
	Tag	Valid	Byte 0	Byte 1	Byte 2	Byte 3	Tag	Valid	Byte 0	Byte 1	Byte 2	Byte 3
0	09	1	86	30	3F	10	00	0	--	--	--	--
1	45	1	60	4F	E0	12	38	1	00	BC	0B	37
2	3B	0	--	--	--	--	0B	0	--	--	--	--
3	06	0	--	--	--	--	32	1	12	08	7B	AD
4	05	1	40	67	C2	3B	67	1	06	78	07	C5
5	71	1	0B	DE	18	4B	6E	0	--	--	--	--
6	51	1	A0	B7	26	2D	20	0	--	--	--	--
7	46	0	--	--	--	--	1E	1	12	C0	88	37

Given the address of **0x705**, provide the following information (make sure you give your answers in binary for parts a-d; only show the exact bits, no leading zeros, and no spaces):

a) What is the block offset (in binary)?

b) What is the set index (in binary)?

c) What is the tag (in binary)?

d) Do we have a cache hit (answer yes or no, all letters in lower cases)?

e) If your answer in part d) is "yes", what is the value of the data (**use the hex value from the table directly**; **do not convert to binary**)? Enter 0 if your answer in part d) is "no".

2. [20 points] Our system has the TLB cache that is direct mapped with an 8-byte line and 16 total entries. The current content of the cache appears below:

Cache: Direct mapped, 8-byte block, 16 Blocks										
Index	*Tag*	*Valid*	*Blk 0*	*Blk 1*	*Blk 2*	*Blk 3*	*Blk 4*	*Blk 5*	*Blk 6*	*Blk 7*
0	19	1	99	11	23	14	21	22	23	24
1	15	0	--	--	--	--	--	--	--	--
2	1B	1	00	02	04	08	0A	0C	10	14
3	36	0	--	--	--	--	--	--	--	--
4	32	1	43	6D	8F	09	67	78	54	11
5	0D	1	36	72	F0	1D	8F	62	34	71
6	31	0	--	--	--	--	--	--	--	--
7	16	1	E1	C2	DF	03	89	91	13	E3
8	24	1	3A	00	51	89	20	21	22	23
9	2D	0	--	--	--	--	--	--	--	--
A	2D	1	93	15	DA	3B	EA	EB	EC	ED
B	0B	0	--	--	--	--	--	--	--	--
C	12	0	--	--	--	--	--	--	--	--
D	16	1	04	96	34	15	F4	91	03	18
E	13	1	83	77	1B	D3	54	31	07	1E
F	14	1	45	23	11	90	91	8C	5F	43

Given the address of **0x16D6**, provide the following information (make sure you give your answers in binary for parts a-d; enter the exact bits, no leading zeros and no spaces):

a) What is the block offset (in binary)?

b) What is the set index (in binary)?

c) What is the tag (in binary)?

d) Do we have a cache hit (yes or no)?

e) If your answer in part d) is "yes", what is the value of the data (**use the hex value from the table directly**; **do not convert to binary**)? Enter 0 if your answer in part d) is "no".

3. [10 points] Consider a virtual memory paging system with the following parameters: 2^{16} bytes of physical memory; page size of 2^{12} bytes; 2^{20} pages of logical address space.

a) How many bits are in a logical address?
b) How many bits in the physical address specify the frame?
c) How many entries are in the page table?

4. [20 points Bonus] Consider the following string of page references 2, 0, 1, 0, 3, 0, 4, 2, 3, 0, 3, 7, 2. Complete a figure similar to the slides assuming 4 frames are available, showing the frame allocation for:

a) FIFO (first-in-first-out)
b) LRU (least recently used)
c) Optimal (assume the page reference string continues with 1, 2, 0, 1, 7, 0,1)
d) List the total number of page faults and the miss rate for each policy.
   Count page faults only after all frames have been initialized.