CS202 · Computer Organization

Homework 4

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June 4, 2022

1 Problem 1

1. Since the offset is 5-bit, with 2-bit byte offset, the cache block size is $2^5/4 = 8$ word.
2. Since the index is 5-bit, the cache has $2^5 = 32$ entries.
3.

Address	0	4	16	132	232	160	1024	30	140	3100	180	2180
Index	0	0	0	4	7	5	0	0	4	0	5	4
Tag	0	0	0	0	0	0	1	0	0	3	0	2
Hit/Miss	*Miss*	*Hit*	*Hit*	*Miss*	*Miss*	*Miss*	*Miss*	*Miss*	*Hit*	*Miss*	*Hit*	*Miss*
Replace	*N*	*N*	*N*	*N*	*N*	*N*	*Y*	*Y*	*N*	*Y*	*N*	*Y*

4.

$$hit\ ratio = \frac{hit}{hit + miss} \times 100\% = \frac{4}{12} \times 100\% = 33.3\%$$

5.

Index	*Tag*	*Data*
0	3	$Men[3072_{10}]$
4	2	$Mem[2176_{10}]$
5	0	$Mem[160_{10}]$
7	0	$Mem[224_{10}]$

2 Problem 2

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Address	17	32	2	2059	4124	65	2067	2200	30	0	4102	360
Index	1	2	0	0	1	4	1	9	1	0	0	22
Tag0	0	0	0	0	0	0	1	1	1	0	0	0
Tag1				1	2		2		0	1	2	
Hit/Miss	*Miss*	*Miss*	*Miss*	*Miss*	*Miss*	*Miss*	*Miss*	*Miss*	*Miss*	*Hit*	*Miss*	*Miss*
Replace	*N*	*N*	*N*	*N*	*N*	*N*	*Y*	*N*	*Y*	*N*	*Y*	*N*

- The cache size is $2^7 \times (2^2 \times 32 + (32 - 7 - 4) + 1) = 19200$ bit $= 600$ word.
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Index	*Tag*	*Data*	*Tag*	*Data*
0	0	$Men[0_{10}]$	2	$Men[4096_{10}]$
1	1	$Mem[2064_{10}]$	0	$Men[16_{10}]$
2	0	$Mem[32_{10}]$		
4	0	$Mem[64_{10}]$		
9	1	$Mem[2192_{10}]$		
22	0	$Mem[352_{10}]$		

3 Problem 3

1. Since $4KiB = 2^{12}$ byte, the needed number of PTEs is $2^{43} \div 2^{12} = 2^{31}$.
2. The needed physical memory is $2^{31} \times 4$ byte = 2^{33} byte.

4 Problem 4

1. To protect a 128-bit word, it must be

$$
\begin{aligned}
& 2^p \geq p + d + 1 \\
\Longrightarrow \ & p \geq \log_2(p + d + 1)
\end{aligned}
$$

   where p is the number of parity bits, d is the number of digital bits. Here $d = 128$.
   To solve this inequality, we can get the minimum number of parity bits is 8.

2. We have $0x5C6 = (0101\_1100\_0110)_2$ with 12 bits. Then we can encode the SEC.

$Bit\ position$	1	2	3	4	5	6	7	8	9	10	11	12	
$Bits$	0	1	0	1	1	1	0	0	0	1	1	0	
$Encoded\ date\ bits$	$p1$	$p2$	$d1$	$p4$	$d2$	$d3$	$d4$	$p8$	$d5$	$d6$	$d7$	$d8$	
$p1$	x		x		x		x		x		x		0
$p2$		x	x			x	x			x	x		0
$p4$				x	x	x	x					x	1
$p8$								x	x	x	x	x	0

   Since $\{p8, p4, p2, p1\} = 0100$, the bit position of 4. The correct value is $(0100\_1100\_0110)_2$, i.e., $0x4C6$.