Solved Exercises 3

1. Solve Problem **8.8** from the textbook.

Since each word contains 4 bytes, the 2 least significant bits identify a byte within a word (**Byte** field). Each block contains 32 words, thus requiring a 5-bit **Word** field. There are 16 sets, requiring a 4-bit **Set** field. The remaining 21 bits of the address is the **Tag** field.

2. Solve Problem **8.11(c)** from the textbook.

(c) Set-associative-mapped cache

	Block position	Contents of data cache after:			
		Pass 1	Pass 2	Pass 3	Pass 4
Set 0	0	[200]	[200]	[200]	[200]
	1	[208]	[208]	[208]	[208]
	2	[2F0]	[2F0]	[2F0]	[2F0]
	3	[218]	[218]	[218]	[218]
Set 1	0	[204]	[204]	[204]	[204]
	1	[24C]	[21C]	[24C]	[21C]
	2	[2F4]	[2F4]	[2F4]	[2F4]
	3	[21C]	[24C]	[21C]	[24C]

Hit rate = 30/48 = 0.63

3. Solve Problem **8.12** from the textbook.

(a) Direct-mapped cache

Block position	Contents of data cache after:			
	Pass 1	Pass 2	Pass 3	Pass 4
0	[200]	[200]	[200]	[200]
	[204]	[204]	[204]	[204]
1	[248]	[248]	[248]	[248]
	[24C]	[24C]	[24C]	[24C]
2	[2F0]	[2F0]	[2F0]	[2F0]
	[2F4]	[2F4]	[2F4]	[2F4]
3	[218]	[218]	[218]	[218]
	[21C]	[21C]	[21C]	[21C]

Hit rate = 37/48 = 0.77

(b) Associative-mapped cache

Block position	Contents of data cache after:			
	Pass 1	Pass 2	Pass 3	Pass 4
0	[200]	[200]	[200]	[200]
	[204]	[204]	[204]	[204]
1	[248]	[218]	[248]	[218]
	[24C]	[21C]	[24C]	[21C]
2	[2F0]	[2F0]	[2F0]	[2F0]
	[2F4]	[2F4]	[2F4]	[2F4]
3	[218]	[248]	[218]	[248]
	[21C]	[24C]	[21C]	[24C]

Hit rate = 34/48 = 0.71

(c) Set-associative-mapped cache

	Block position	Contents of data cache after:			
		Pass 1	Pass 2	Pass 3	Pass 4
Set 0	0	[200]	[200]	[200]	[200]
		[204]	[204]	[204]	[204]
	1	[2F0]	[2F0]	[2F0]	[2F0]
		[2F4]	[2F4]	[2F4]	[2F4]
Set 1	0	[248]	[218]	[248]	[218]
		[24C]	[21C]	[24C]	[21C]
	1	[218]	[248]	[218]	[248]
		[21C]	[24C]	[21C]	[24C]

Hit rate = 34/48 = 0.71

4. Solve Problem **8.14** from the textbook.

The average access time for a two-level cache is given by:

$$t_{avg} = h_1 C_1 + (1 - h_1)(h_2 C_2 + (1 - h_2)M)$$

For $C_1 = \tau$, $C_2 = 15\tau$, and $M = 100\tau$. The average access times are given in the following table:

h_1	0.90	0.92	0.94	0.96
$h_2 = 0.75$	4.53τ	3.82τ	3.12τ	2.41τ
$h_2 = 0.85$	3.68τ	3.14τ	2.61τ	2.07τ