DKT217 COMPUTER SYSTEM TOPUP MTE
DATE : FRIDAY 10 APRIL 2020
TIME : 9.30am ~ 11.00am
DURATION : 1 HOUR 30 MINUTES
UPLOAD CUT-OFF : 11.02am

ANSWER ALL QUESTIONS

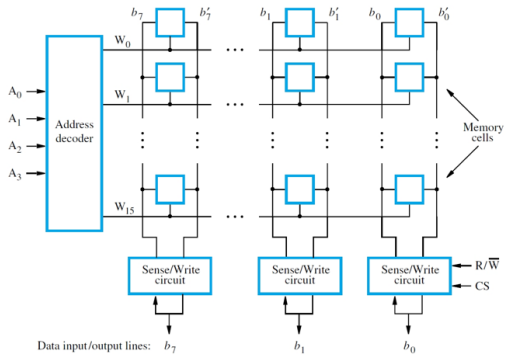
QUESTION 1

a) A 1K-bit memory cell can be organized into 128x8 or 1024x1 arrays. Draw the block diagram for both memory organization.

(5 marks)

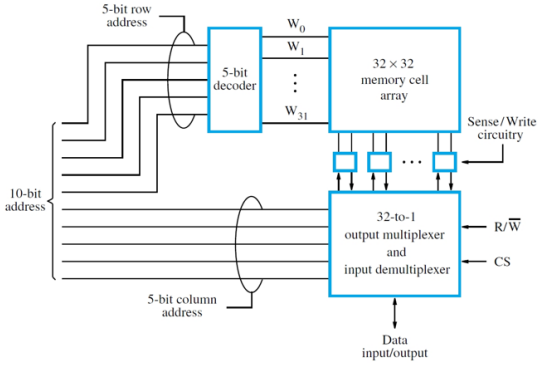
SOLUTION

128 x 8 array organization (8-bit output)



Using 7 to 128 bit decoder

1024 x 1 array organization (1-bit output)



Using 5 bits decoder for row and 5 bits mux for column.

QUESTION 2

An 8-bit data E8H is to be stored into the memory.

a) Find the Kin code when the data is stored into the memory.

b) Find the Kout code when the data is taken out from the memory if the data becomes ECH.

c) Determine the syndrome which proves the location of the faulty bit from the 8-bit data.

SOLUTION

Finding K-bits :

$2^K - 1 \geq M + K$ → try and error we get K=4 bits when M is 8.

So :

Locations in decimal and binary	12	11	10	9	8	7	6	5	4	3	2	1
	1100	1011	1010	1001	1000	0111	0110	0101	0100	0011	0010	0001
M & K bit positions	M7	M6	M5	M4	K_3	M3	M2	M1	K_2	M0	K_1	K_0
Data In E8H	1	1	1	0		1	0	0		0		
Data Out ECH	1	1	1	0		1	1	0		0		

a) Finding Kin code values :

K0 = M0 ⊕ M1 ⊕ M3 ⊕ M4 ⊕ M6 => 0
K1 = M0 ⊕ M2 ⊕ M3 ⊕ M5 ⊕ M6 => 1
K2 = M1 ⊕ M2 ⊕ M3 ⊕ M7 => 0
K3 = M4 ⊕ M5 ⊕ M6 ⊕ M7 => 1

Thus, the exact data E8H (11101000B) to be stored into memory is EC2H (111011000010B), but the question only asks for the Kin code which is **1010B**.

b) Finding Kout code values :

K0 = M0 ⊕ M1 ⊕ M3 ⊕ M4 ⊕ M6 => 0
K1 = M0 ⊕ M2 ⊕ M3 ⊕ M5 ⊕ M6 => 0
K2 = M1 ⊕ M2 ⊕ M3 ⊕ M7 => 1
K3 = M4 ⊕ M5 ⊕ M6 ⊕ M7 => 1

Thus, the exact data ECH (11101100B) to be loaded from memory is EE8H (111011101000B), but the question only asks for the Kout code which is **1100B**.

c) Getting the syndrome which points to location of the faulty bit :

Kin 1010
⊕Kout 1100
Syndrome 0110 ← this is the table location that refers to M2 bit

The syndrome points to M2 which shows the value differences when storing (0) and when loading (1).

[5 marks]

QUESTION 3

a) Assume a computer has the memory with the size of 16MB and a cache size of 64KB that addresses at the byte level. If the computer's cache line can contain 16 bytes, determine the format sizes of the following cache map :

(i) Direct Mapped Cache

(ii) Associative Mapped Cache

(iii) 2-way Set Associative Mapped Cache

b) Assuming a memory has 128 blocks and a cache consists of 32 lines. Determine where the 78^{th} memory block will be located in the cache for :

(i) Direct Mapped Cache

(ii) Associative Mapped Cache

(iii) 4-way Set Associative Mapped Cache

SOLUTION

a) Memory size is 16MB, expressed in the power of 2 is 2^{24} ,
Cache size is 64KB, expressed in the power of 2 is 2^{16} ,
Cache line size is 16B, expressed in the power of 2 is 2^{4} ,

(i) Direct Mapped Cache
- Total addressable bits, s+w = 24
- Cache line size, w = 4
- Total addressable cache lines, r+w = 16
- Addressable cache lines, r = 12
- Block format

24 bit (s+w)

Tag, s-r	Line, r	Size, w
8	12	4

(ii) Associative Mapped Cache
- Total addressable bits, s+w = 24
- Cache line size, w = 4
- No addressable cache lines needed, just total tag, s
- Block format

24 bit (s+w)

Tag, s	Size, w
20	4

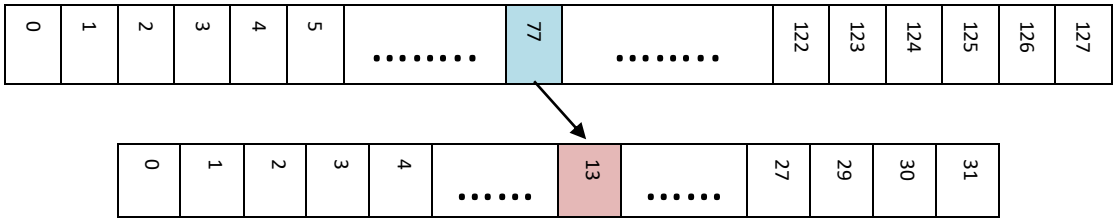
(iii) 2-way Set Associative Mapped Cache
- Total addressable bits, s+w = 24
- Cache line size, w = 4
- Total addressable cache lines, r+w = 16
- X-way addressable, 2^k, k =1
- Addressable set bits, d = r-1 = 11
- Block format

24 bit (s+w)

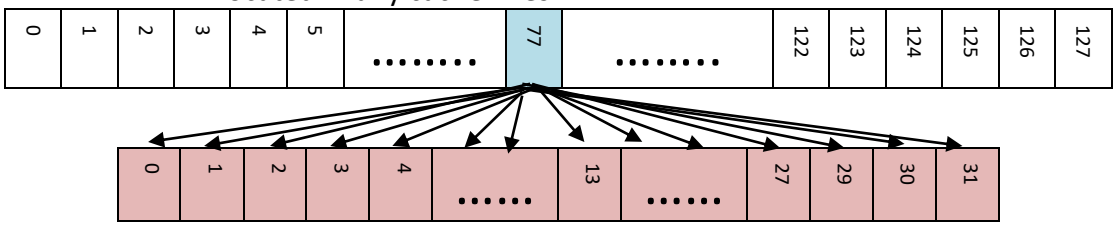
Tag, s-d	Set, d	Size, w
9	11	4

b) Memory blocks = 128
Cache lines = 32
Location for memory block 78 inside the cache using :

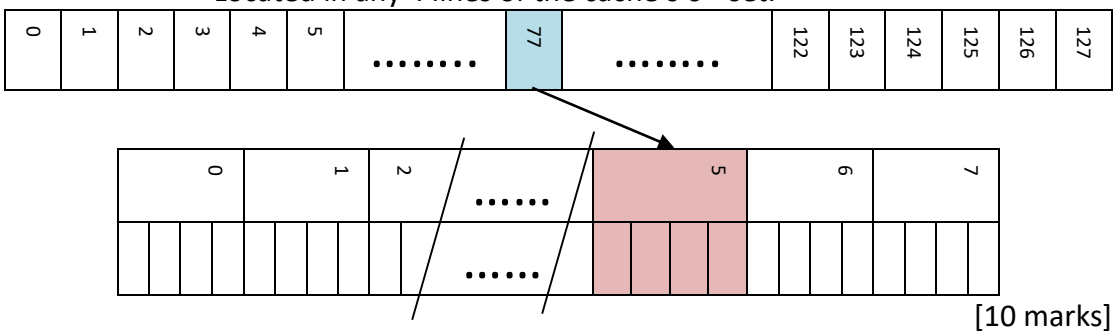
(i) Direct Mapped
- Located in the cache's 14th line



(ii) Associative Mapped
- Located in any cache lines



(iii) 4-way Set Associative Mapped
- Located in any 4 lines of the cache's 6th set.



[10 marks]

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