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OBJECT

# sheet 1

7

System Memory = 128 MB.

Cashé → 32 K blocks

→ 64 bytes.  $\rightarrow 2^6$

tag                  set                  offset

111	14	6
-----	----	---

27 bit

$$\text{No. of sets} = \frac{\text{no. of blocks}}{\text{No. of bits}}$$

$$= \frac{32 \cdot 2^{10}}{2^5} = \frac{2^5 \cdot 2^{10}}{2^5} = \frac{2^{15}}{2^5}$$

$$= 2^{14} \text{ set.}$$

Total Main Memory = 128 MB

$$= 128 \cdot 2^{20} = 2^7 \cdot 2^{20} = 2^{27} \text{ bytes}$$

g

total Main Memory =  $2^{16}$  bytes

Cashel  $\rightarrow$  32 block

each block has 8 bytes

a) 2 way set associative.

tag	Set	offset
9	4	3

← 16 bits

$$\text{no. of sets} = \frac{32}{2} = 16 \rightarrow 2^4$$

b) 4 way set associative.

tag	set	offset
10	3.	3

16 bit.

$$\text{no. of sets} = \frac{32}{4} = 8 \rightarrow 2^3$$

Total Main Memory =  $2^{21}$  byte

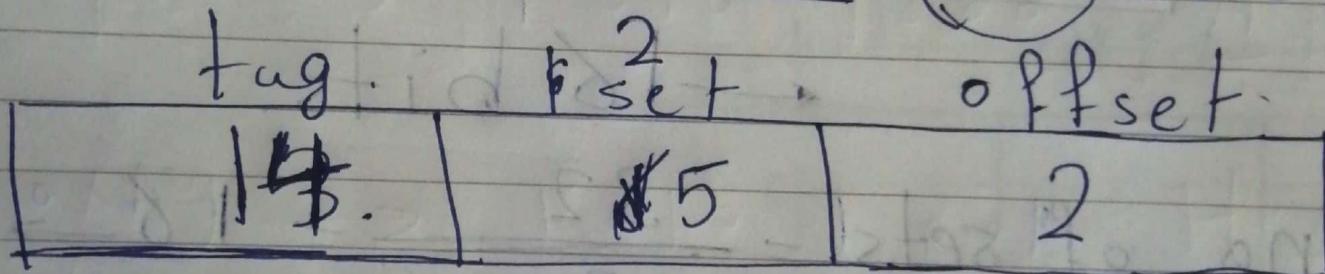
Cash

$\rightarrow$  64 block

$\rightarrow$  each block is  $2^2$  byte.

a) in 2-way setassociative:

No. of sets =  $\frac{64}{2} = 32$  sets.

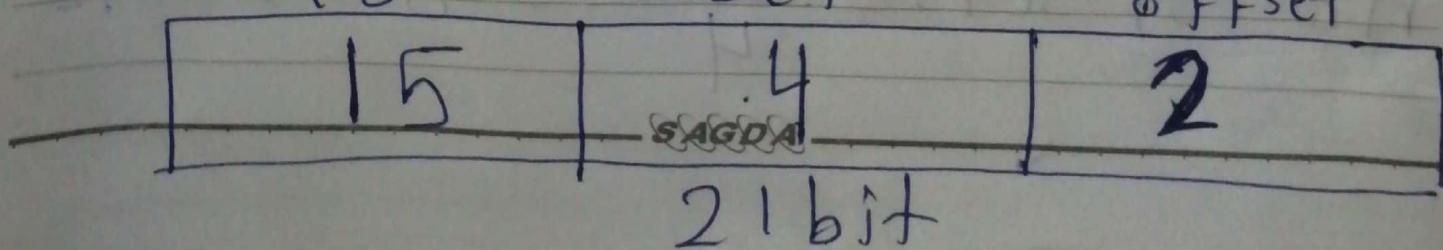


21 bit

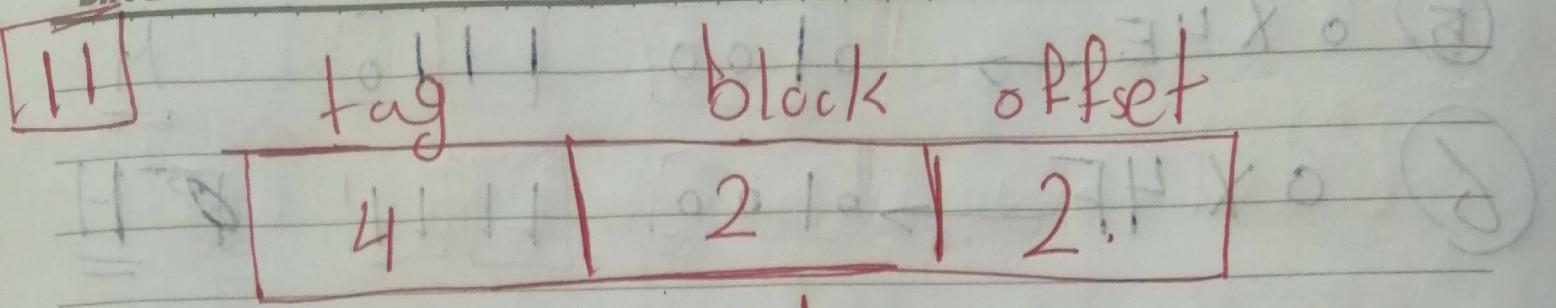
b) in 4-way setassociative:

No. of sets =  $\frac{64}{4} = \frac{2^6}{2^2} = 2^4$

= 16 set set  $\rightarrow$  offset



21 bit



Cash size = 16 bytes

each block have 4 bytes

$$\text{n.o. of block} = \frac{16}{4} = 4 \rightarrow 2^2$$

1)  $0x6E \rightarrow 8421$        $8421$

(Miss) |  $0110$  |  $1100$  |  $1100$  |  $1100$  |  $0001$  |  $0x16$  |  $0x96$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x17$  |  $0x97$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x18$  |  $0xA8$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x19$  |  $0xA9$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1A$  |  $0xAA$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1B$  |  $0xAB$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1C$  |  $0xAC$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1D$  |  $0xAD$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1E$  |  $0xAE$

$0110$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1F$  |  $0xAF$

2)  $0xB9 \rightarrow 1011101011100100$

$1100$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x18$  |  $0xA8$

$1100$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x19$  |  $0xA9$

$1100$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1A$  |  $0xAA$

$1100$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1B$  |  $0xAB$

$1100$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1C$  |  $0xAC$

$1100$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1D$  |  $0xAD$

$1100$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1E$  |  $0xAE$

$1100$  |  $1100$  |  $1100$  |  $1100$  |  $1100$  |  $0x1F$  |  $0xAF$

3)  $0x17 \rightarrow 10001011100100$

$0001$  |  $0111$  |  $1000$  |  $1000$  |  $0001$  |  $0x18$  |  $0xA8$

$0001$  |  $0111$  |  $1000$  |  $1000$  |  $0001$  |  $0x19$  |  $0xA9$

$0001$  |  $0111$  |  $1000$  |  $1000$  |  $0001$  |  $0x1A$  |  $0xAA$

$0001$  |  $0111$  |  $1000$  |  $1000$  |  $0001$  |  $0x1B$  |  $0xAB$

$0001$  |  $0111$  |  $1000$  |  $1000$  |  $0001$  |  $0x1C$  |  $0xAC$

$0001$  |  $0111$  |  $1000$  |  $1000$  |  $0001$  |  $0x1D$  |  $0xAD$

$0001$  |  $0111$  |  $1000$  |  $1000$  |  $0001$  |  $0x1E$  |  $0xAE$

$0001$  |  $0111$  |  $1000$  |  $1000$  |  $0001$  |  $0x1F$  |  $0xAF$

4)  $0xE0 \rightarrow 1110000000000000$

$1110$  |  $0000$  |  $0000$  |  $0000$  |  $0000$  |  $0x18$  |  $0xA8$

$1110$  |  $0000$  |  $0000$  |  $0000$  |  $0000$  |  $0x19$  |  $0xA9$

$1110$  |  $0000$  |  $0000$  |  $0000$  |  $0000$  |  $0x1A$  |  $0xAA$

$1110$  |  $0000$  |  $0000$  |  $0000$  |  $0000$  |  $0x1B$  |  $0xAB$

$1110$  |  $0000$  |  $0000$  |  $0000$  |  $0000$  |  $0x1C$  |  $0xAC$

$1110$  |  $0000$  |  $0000$  |  $0000$  |  $0000$  |  $0x1D$  |  $0xAD$

$1110$  |  $0000$  |  $0000$  |  $0000$  |  $0000$  |  $0x1E$  |  $0xAE$

$1110$  |  $0000$  |  $0000$  |  $0000$  |  $0000$  |  $0x1F$  |  $0xAF$

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8 9 2 1

⑤  $0 \times 4E \rightarrow$ 

0100	1110
------	------

 M

⑥  $0 \times 4F \rightarrow$ 

0100	1111
------	------

 H

⑦  $0 \times 50 \rightarrow$ 

0101	0000
------	------

 M

⑧  $0 \times 91 \rightarrow$ 

1001	0001
------	------

 M

⑨  $0 \times A8 \rightarrow$ 

1010	1000
------	------

 M

⑩  $0 \times A9 \rightarrow$ 

11010	1001
-------	------

 H

⑪  $0 \times AB \rightarrow$ 

1010	11011
------	-------

 H

⑫  $0 \times AD \rightarrow$ 

1010	11101
------	-------

 M  
 $0 \times AC \rightarrow$ 

1010	111000
------	--------

⑬  $0 \times A93 \rightarrow$ 

1001	0011
------	------

 H

⑭  $0 \times 94 \rightarrow$ 

1001	0100
------	------

 M

~~hit ratio = 11 / 12 =~~

$$\text{hit ratio} = 4 / 14 = 28.6\%.$$

$$\text{Miss ratio} = 1 - \text{hit ratio}$$

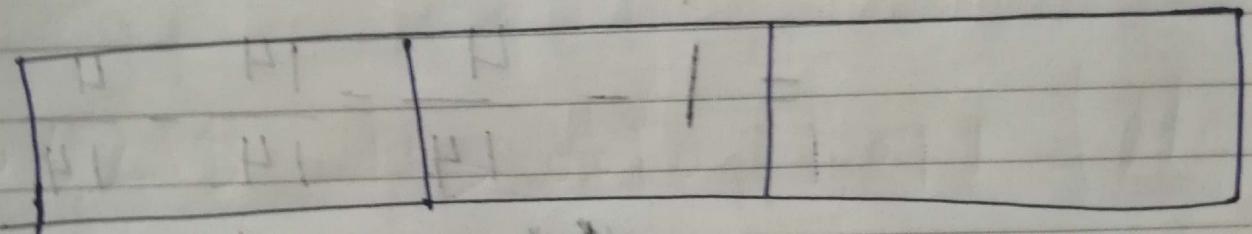
$$= 1 - \frac{4}{14} = \frac{14}{14} - \frac{4}{14} = \frac{10}{14}$$

~~37~~ 8.4 %

Total main Memory - 256 byte

Cashes  $\rightarrow$  4 blocks

$\hookrightarrow$  each block have 8 bytes.

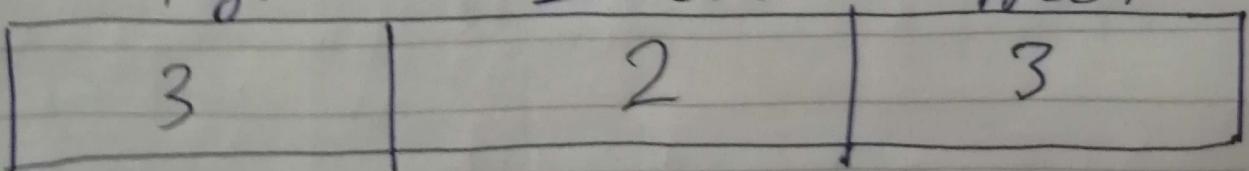


a) no. of blocks in Cashe =  $\frac{256}{8}$

$$= \frac{2^8}{2^3} = 2^5 \text{ blocks } 32 \text{ blocks}$$

b). direct Mapping.

i) tag.      ~~set~~ block      offset



8 bits

## Cache

iii) ten access.

①  $0x2C \rightarrow 0010\ 1100$   
 (Miss)

Start  $\rightarrow 0010\ 1000$   
 End  $\rightarrow 0010\ 1111$

②  $0x6D \rightarrow 0110\ 1101$   
 (Miss)

Start  $= 0x68 \leftarrow 0110\ 1000$   
 End  $= 0x6F \leftarrow 0110\ 1111$

③  $0x86 \rightarrow 1000\ 0110$   
 (Miss)

Start  $\rightarrow 0x80\ 1000\ 0000$   
 End  $\rightarrow 0x87\ 1000\ 0111$

④  $0x29 \rightarrow 0010\ 1001$   
 (Miss)

⑤  $0xA5 \rightarrow 1010\ 0101$   
 (Miss)

$0xA0 \leftarrow 1010\ 0000$   
 $0xA7 \quad 1010\ 0111$

Tag	8421	8421	8421	8421	8421	8421	8421	8421	8421	8421
100	0x80	0xA6								
101	0x81	0xA1								
102	0x82	0xA2								
103	0x83	0xA3								
104	0x84	0xA4								
105	0x85	0xA5								
106	0x86	0xA6								
107	0x87	0xA7								
108	0x28	0x68								
109	0x29	0x69								
110	0x2A	0x6A								
111	0x2B	0x6B								
112	0x2C	0x6C								
113	0x2D	0x6D								
114	0x2E	0x6E								
115	0x2F	0x6F								

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- ⑥  $0 \times 82 \rightarrow [1000 \quad 0010]$  (Miss)
- ⑦  $0 \times A7 \rightarrow 1010 \quad 0111$  (Miss)
- ⑧  $0 \times 68 \rightarrow [0110 \quad 1000]$  (Miss)
- ⑨  $0 \times 80 \rightarrow [1000 \quad 0000]$  (Miss)
- ⑩  $0 \times 2B \rightarrow [0010 \quad 011]$  (Miss)

Miss rate = 100%

hit rate = 0%

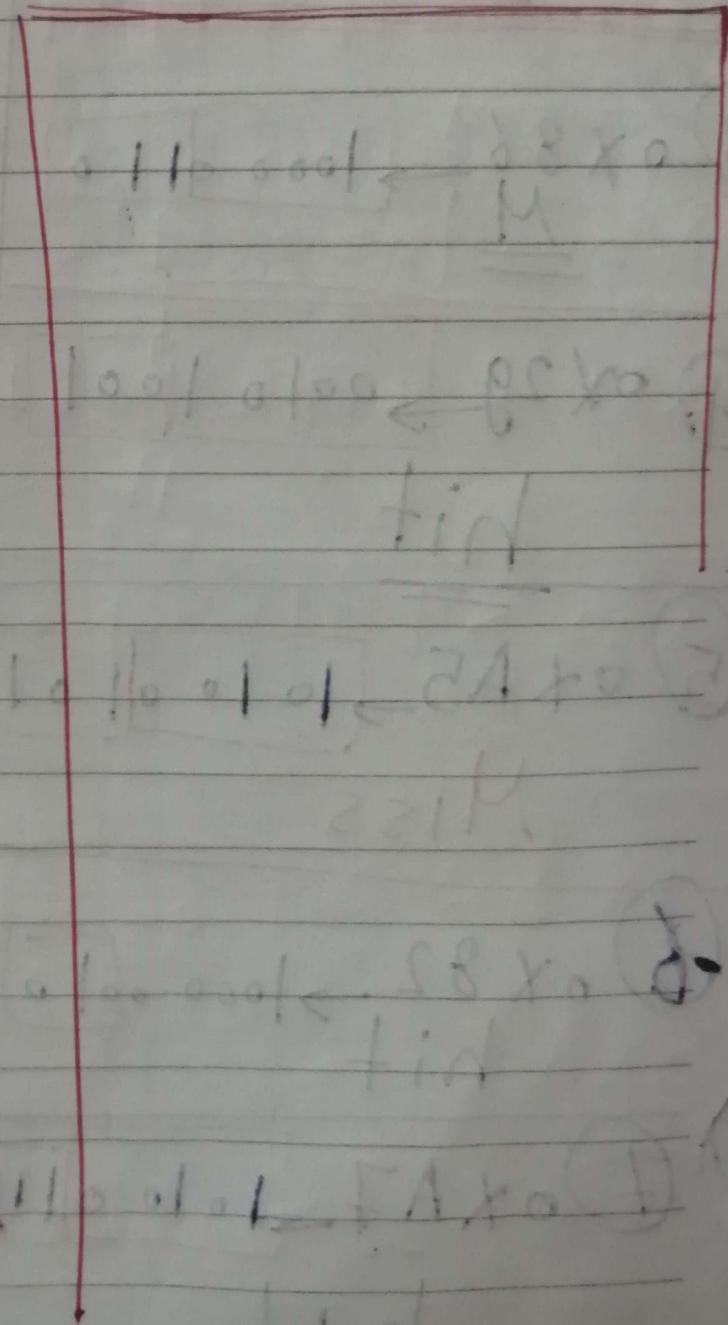
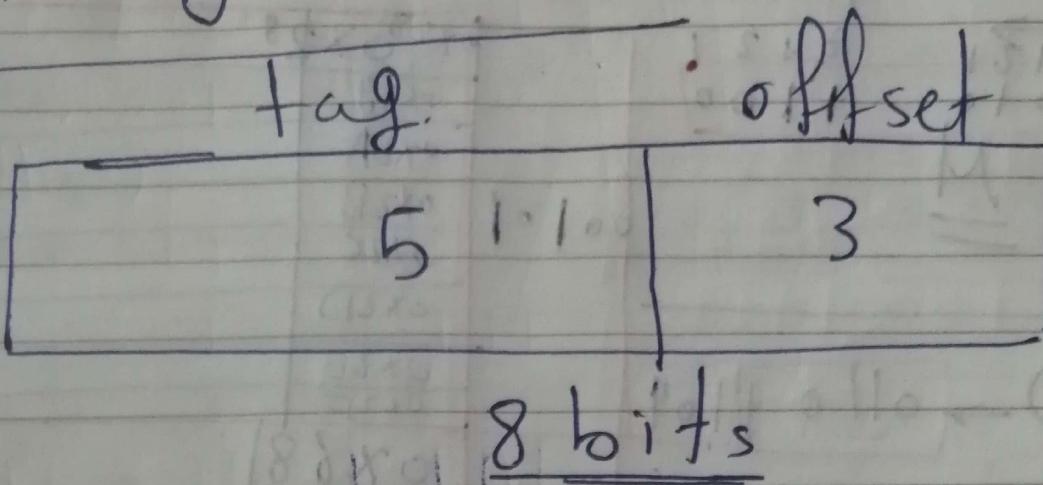
1001 0100 < 001000

(22iH)

(22iH)

1010 0101 < 001000  
0010 0101 < 001000  
1110 0101 < 001000

c) Fully associative



①  $0 \times 2C$  $0 \times 2C \rightarrow 8421$ ~~Miss~~8421  
0010M

1100

~~log~~

00101

~~0x28~~  
~~0x28~~

0x29

0x2A

0x2B

0x2C

0x2D

0x2E

0x2F

0x68

0x69

0x6A

0x6B

0x6C

0x6D

0x6E

0x6F

0x80

0x81

0x82

0x83

0x84

0x85

0x86

0x87

0xA0

0xA1

0xA2

0xA3

0xA4

0xA5

0xA6

0xA7

②  $0 \times 6D$ M③  $0 \times 86$ M④  $0 \times 29$ hit⑤  $0 \times A5$ Miss⑥  $0 \times 82$ hit⑦  $0 \times A7$ hit

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- ⑧  $0x68 \rightarrow [011011|000]$  hit
- ⑨  $0x80 \rightarrow [100000|000]$  hit
- ⑩  $0x2B \rightarrow [00101|001]$  hit

$$\text{hit ratio} = \frac{6}{10} = 60\%$$

$$\text{Miss ratio} = 1 - \text{hit ratio} = 1 - \frac{6}{10} = \frac{4}{10} = 40\%$$

2 way set association:

tag.	set	offset
4	1	3

$$\text{no. of sets} = \frac{8 \text{ bit}}{4} = 2 \rightarrow 2^1$$

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8421 8421  
0x2C → 0010 [1100]  
M

S → 0010 1000  
E → 0010 1111  
    ↓  
    0x2F

tag

Cash

0x80

0x81

0x82

0x83

0x84

0x85

0x86

0x87

b0 set0

0x6D → M 0110 [1101]

1010

b1

0x86 → 1000 0110

0010

b2

0x29 → 0010 1001  
H

0x28  
0x29  
0x2A  
0x2B  
0x2C  
0x2D  
0x2E  
0x2F

set1

0xA5 → 1010 0101  
M

0110

b3

0x68  
0x69  
0x6A  
0x6B  
0x6C  
0x6D  
0x6E  
0x6F

0x82 → 1000 0010 → H

0xA7 → 1010 0111 → H

0x68 → 0110 1000 → H

0x80 → 1000 0000 → H

SAGRA

$0x2B \rightarrow [0010] [1011] \rightarrow H$

$$\text{hit ratio} = 6/10 = 60\%$$

$$\text{Miss ratio} = 1 - \frac{6}{10} = 4/10 = 40\%$$

$$EAT = \text{hit} \times \text{Access}_{\text{Main Memory}} + (1 - \text{hit}) \times$$

Access  
Main Memory

$$EAT = .6 * (5 \times 10^{-9}) + (.4) * (25 \times 10^{-9}) \\ = 15 \times 10^{-9} \text{ sec}$$

= or

$$= .6 * (5) + (.4) * (25 + 5)$$

$$= 15 \text{ nsec}$$