

DATE //

OBJECT

sheet + 1

[7]

System Memory = 128 MB.

Casher → 32 K blocks

→ 64 bytes → 2^8

tag set offset

17	14	6
----	----	---

27 bit

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

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

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

Total Main Memory = 128 MB

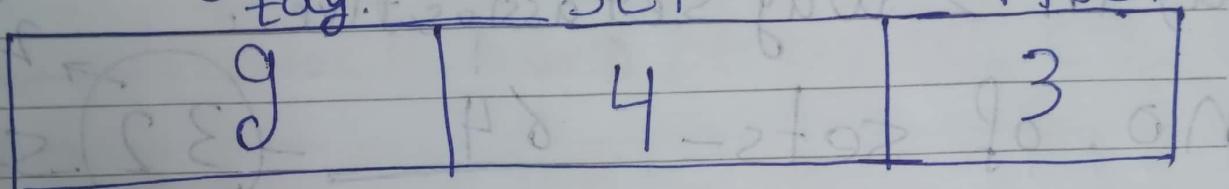
$$= 128 \cdot 2^{20} = 2^7 \cdot 2^{20} = 2^{27} \text{ bytes}$$

[g] Is total Main Memory = 2^{16} bytes.

Cash → 32 block

→ each block has 8 bytes

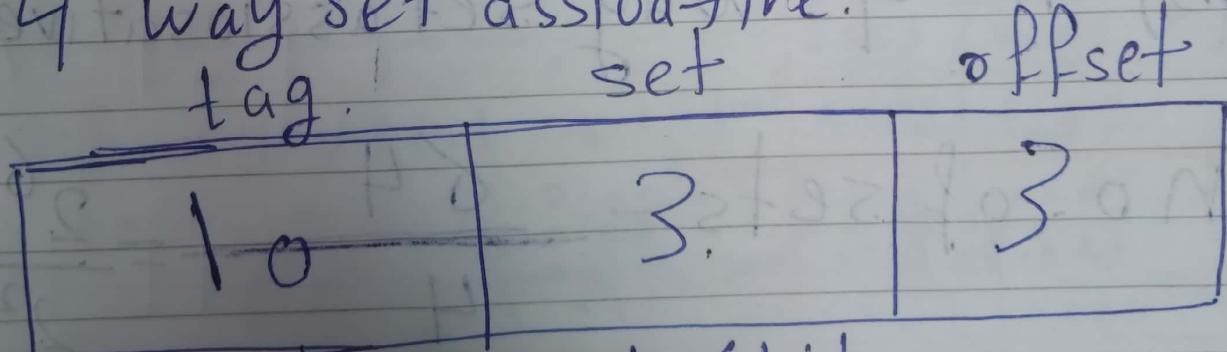
a) 2 way set associative.



→ 16 bits.

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

b) 4 way set associative.



16 bit.

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

110

21

total Main Memory = 2^{21} byte

Cash → 64 block

\rightarrow each block is 4 byte.

a) in 2-way setassociative:

No. of sets = $\frac{64}{2^5} = 32$ sets.

tag: id $\xrightarrow{2^2}$ set offset: $\xrightarrow{2^5}$

14	5	2
----	---	---

21 bit

b) in 4-way setassociative:

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

= 16 set $\xrightarrow{2^4}$ set offset

15	4	2
----	---	---

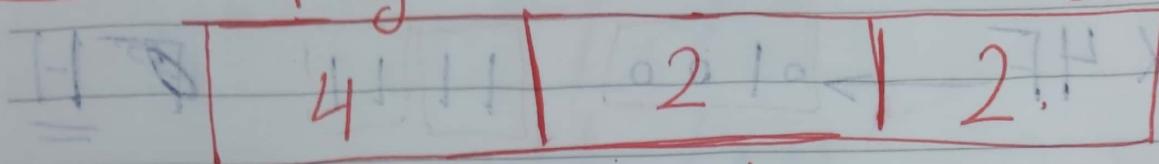
21 bit

III

tag

block

offset



8 bit

Cache size = 16 bytes.

each block have 4 bytes

$$\text{N. o f block} = \frac{16}{4} = 4 \rightarrow 2^2 \text{ Cache blocks}$$

① $0 \times 6E \rightarrow 11011011001100$
 (Miss)

tag	0XE0	0X50	0X90
110	0XE1	0X51	0X91
110	0XE2	0X52	0X92
010	0XE3	0X53	0X93
	0X14	0X94	
	0X15	0X95	
	0X16	0X96	
	0X17	0X97	

② $0 \times B9 \rightarrow 11011010011000$

0000	0XB8	0XA8	2
0001	0XB9	0XA9	
0010	0XB A	0XA A	
0011	0XB B	0XA B	

③ $0 \times 17 \rightarrow 00010111$

0000	0X6C	0X4C	0XAC
0001	0X6D	0X4D	0XAD
0010	0X6E	0X4E	0XAE
0011	0X6F	0X4F	0XAF

④ $0 \times E0 \rightarrow 11010000$

DATE / /

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8 4 2 1

⑤ $0 \times 4E \rightarrow$

0 1 0 0

1 1 1 0

M H

⑥ $0 \times 4F \rightarrow$

0 1 0 0

1 1 1 1

H H

⑦ $0 \times 50 \rightarrow$

0 1 0 1

0 0 0 0

M M

⑧ $0 \times 91 \rightarrow$

1 0 0 1

0 0 0 1

M M

⑨ $0 \times A8 \rightarrow$

1 0 1 0

1 0 0 0

M M

⑩ $0 \times A9 \rightarrow$

1 1 1 0

1 1 0 1

H H

⑪ $0 \times ABE \rightarrow$

1 0 1 0

1 1 0 1

H H

⑫ $0 \times AD \rightarrow$

1 0 1 0

1 1 1 0

M M

⑬ $0 \times AC \rightarrow$

1 0 1 0

1 1 1 0

M M

⑭ $0 \times A93 \rightarrow$

1 0 0 1

0 0 1 1

H H

⑮ $0 \times 94 \rightarrow$

1 0 0 1

0 1 0 0

M M

$$\cancel{71.4 + 28.6} =$$

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$$\text{hit ratio} = \frac{4}{14} =$$

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

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

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

$$= 71.4\%$$

engg. tools. (d)

toffo should be (i)

8	2	1	8
---	---	---	---

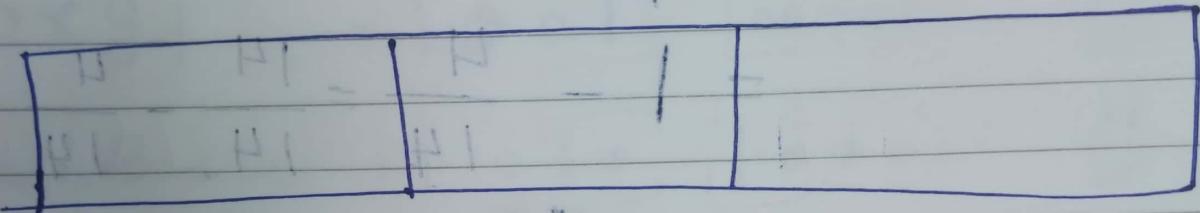
ctrl 8

(12)

total main Memory = 256 byte

Cashel \rightarrow 4 blocks

\hookrightarrow each block have 8 bytes.



8 bits

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

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

b). direct Mapping.

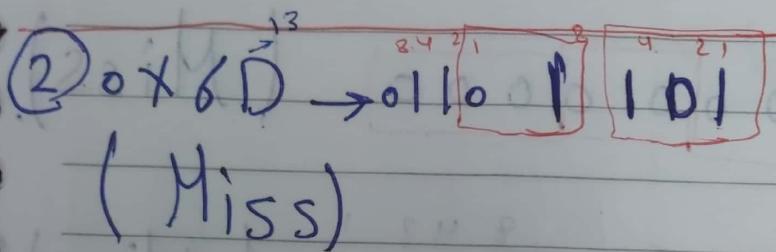
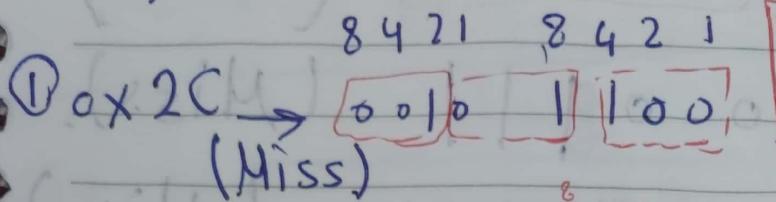
i) tag. ~~set~~ block offset



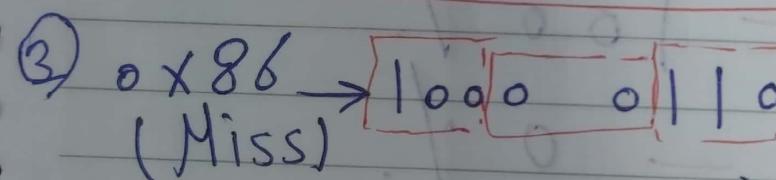
8 bits

Cashe

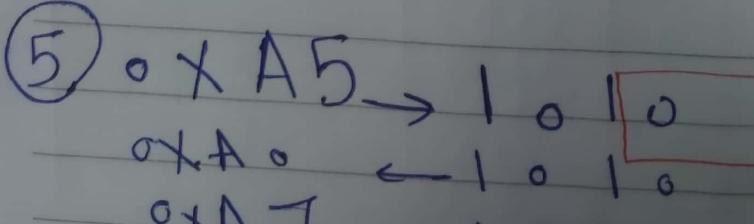
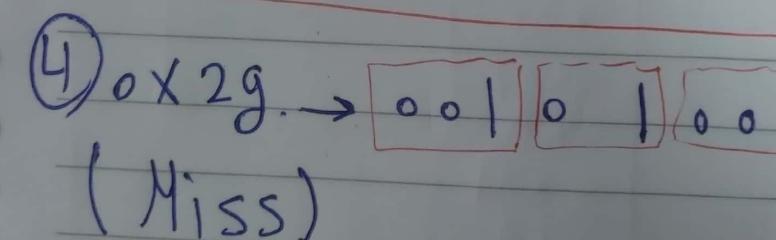
ii) ten access.



start = $0x68 \leftarrow$
 End = $0x6F \leftarrow$



Start \rightarrow $0x80 | 0000$
 End \rightarrow $0x87 | 0000$

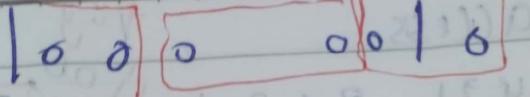


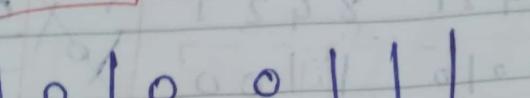
Tag	8421	8421	8421	8421	8421	8421	8421	8421	8421
100	0x86	0xA6	0x80	0xA0	0x80	0xA0	0x80	0xA0	0x80
101	0x81	0xA1	0x81	0xA1	0x81	0xA1	0x81	0xA1	0x81
110	0x82	0xA2	0x82	0xA2	0x82	0xA2	0x82	0xA2	0x82
111	0x83	0xA3	0x83	0xA3	0x83	0xA3	0x83	0xA3	0x83
100	0x84	0xA4	0x84	0xA4	0x84	0xA4	0x84	0xA4	0x84
101	0x85	0xA5	0x85	0xA5	0x85	0xA5	0x85	0xA5	0x85
110	0x86	0xA6	0x86	0xA6	0x86	0xA6	0x86	0xA6	0x86
111	0x87	0xA7	0x87	0xA7	0x87	0xA7	0x87	0xA7	0x87
001	0x28	0x68	0x28	0x68	0x28	0x68	0x28	0x68	0x68
000	0x29	0x69	0x29	0x69	0x29	0x69	0x29	0x69	0x69
001	0x2A	0x6A	0x2A	0x6A	0x2A	0x6A	0x2A	0x6A	0x6A
000	0x2B	0x6B	0x2B	0x6B	0x2B	0x6B	0x2B	0x6B	0x6B
011	0x2C	0x6C	0x2C	0x6C	0x2C	0x6C	0x2C	0x6C	0x6C
000	0x2D	0x6D	0x2D	0x6D	0x2D	0x6D	0x2D	0x6D	0x6D
001	0x2E	0x6E	0x2E	0x6E	0x2E	0x6E	0x2E	0x6E	0x6E
000	0x2F	0x6F	0x2F	0x6F	0x2F	0x6F	0x2F	0x6F	0x6F

2

3

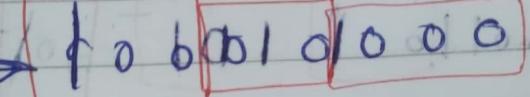
DATE / / OBJECT

⑥ $0 \times 82 \rightarrow$  (Miss)

⑦ $0 \times A7 \rightarrow$  (Miss)

⑧ $0 \times 68 \rightarrow$  (Miss)

⑨ $0 \times 80 \rightarrow$  (Miss)

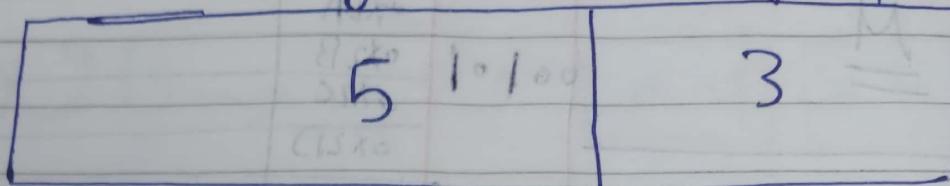
⑩ $0 \times 2B \rightarrow$  (Miss)

Miss rate = 100%.

hit rate = 0%.

c) Fully associative

Tag offset



8 bits

00X0 10110
01X0
10X0
11X0
20X0
21X0
22X0
23X0
24X0
25X0
26X0
27X0
28X0
29X0
2AX0
2BX0
2CX0
2DX0
2FX0
30X0
31X0
32X0
33X0
34X0
35X0
36X0
37X0
38X0
39X0
3AX0
3BX0
3CX0
3DX0
3FX0
40X0
41X0
42X0
43X0
44X0
45X0
46X0
47X0
48X0
49X0
4AX0
4BX0
4CX0
4DX0
4FX0
50X0
51X0
52X0
53X0
54X0
55X0
56X0
57X0
58X0
59X0
5AX0
5BX0
5CX0
5DX0
5FX0
60X0
61X0
62X0
63X0
64X0
65X0
66X0
67X0
68X0
69X0
6AX0
6BX0
6CX0
6DX0
6FX0
70X0
71X0
72X0
73X0
74X0
75X0
76X0
77X0
78X0
79X0
7AX0
7BX0
7CX0
7DX0
7FX0
80X0
81X0
82X0
83X0
84X0
85X0
86X0
87X0
88X0
89X0
8AX0
8BX0
8CX0
8DX0
8FX0
90X0
91X0
92X0
93X0
94X0
95X0
96X0
97X0
98X0
99X0
9AX0
9BX0
9CX0
9DX0
9FX0
A0X0
A1X0
A2X0
A3X0
A4X0
A5X0
A6X0
A7X0
A8X0
A9X0
AAX0
ABA0
ACA0
D0X0
D1X0
D2X0
D3X0
D4X0
D5X0
D6X0
D7X0
D8X0
D9X0
DAX0
D BX0
DCX0
DDX0
DFX0
E0X0
E1X0
E2X0
E3X0
E4X0
E5X0
E6X0
E7X0
E8X0
E9X0
EAX0
EBX0
ECX0
EDX0
EFX0
F0X0
F1X0
F2X0
F3X0
F4X0
F5X0
F6X0
F7X0
F8X0
F9X0
FAX0
FBX0
FCX0
FDX0
FFX0
G0X0
G1X0
G2X0
G3X0
G4X0
G5X0
G6X0
G7X0
G8X0
G9X0
GAX0
GBX0
GCX0
GDX0
GFX0
H0X0
H1X0
H2X0
H3X0
H4X0
H5X0
H6X0
H7X0
H8X0
H9X0
HAX0
HBX0
HCX0
HDX0
HFX0
I0X0
I1X0
I2X0
I3X0
I4X0
I5X0
I6X0
I7X0
I8X0
I9X0
IAX0
IBX0
ICX0
IDX0
IFX0
J0X0
J1X0
J2X0
J3X0
J4X0
J5X0
J6X0
J7X0
J8X0
J9X0
JAX0
JBX0
JCX0
JDX0
JFX0
K0X0
K1X0
K2X0
K3X0
K4X0
K5X0
K6X0
K7X0
K8X0
K9X0
KAX0
KBX0
KCX0
KD
L0X0
L1X0
L2X0
L3X0
L4X0
L5X0
L6X0
L7X0
L8X0
L9X0
LAX0
LBX0
LCX0
LDX0
LFX0
M0X0
M1X0
M2X0
M3X0
M4X0
M5X0
M6X0
M7X0
M8X0
M9X0
MAX0
MBX0
MCX0
MDX0
MFX0
N0X0
N1X0
N2X0
N3X0
N4X0
N5X0
N6X0
N7X0
N8X0
N9X0
NAX0
NBX0
NCX0
NDX0
NFX0
O0X0
O1X0
O2X0
O3X0
O4X0
O5X0
O6X0
O7X0
O8X0
O9X0
OAX0
OBX0
OCX0
ODX0
OFX0
P0X0
P1X0
P2X0
P3X0
P4X0
P5X0
P6X0
P7X0
P8X0
P9X0
PAX0
PBX0
PCX0
PDX0
PFX0
Q0X0
Q1X0
Q2X0
Q3X0
Q4X0
Q5X0
Q6X0
Q7X0
Q8X0
Q9X0
QAX0
QBX0
QCX0
QDX0
QFX0
R0X0
R1X0
R2X0
R3X0
R4X0
R5X0
R6X0
R7X0
R8X0
R9X0
RAX0
RBX0
RCX0
RD
S0X0
S1X0
S2X0
S3X0
S4X0
S5X0
S6X0
S7X0
S8X0
S9X0
SAX0
SBX0
SCX0
SDX0
SFX0
T0X0
T1X0
T2X0
T3X0
T4X0
T5X0
T6X0
T7X0
T8X0
T9X0
TAX0
TBX0
TCX0
TDX0
TFX0
U0X0
U1X0
U2X0
U3X0
U4X0
U5X0
U6X0
U7X0
U8X0
U9X0
UAX0
UBX0
UCX0
UDX0
UFX0
V0X0
V1X0
V2X0
V3X0
V4X0
V5X0
V6X0
V7X0
V8X0
V9X0
VAX0
VBX0
VCX0
VDX0
VFX0
W0X0
W1X0
W2X0
W3X0
W4X0
W5X0
W6X0
W7X0
W8X0
W9X0
WAX0
WBX0
WCX0
WDX0
WFX0
X0X0
X1X0
X2X0
X3X0
X4X0
X5X0
X6X0
X7X0
X8X0
X9X0
XAX0
XBX0
XCX0
XD
Y0X0
Y1X0
Y2X0
Y3X0
Y4X0
Y5X0
Y6X0
Y7X0
Y8X0
Y9X0
YAX0
YBX0
YCX0
YDX0
YFX0
Z0X0
Z1X0
Z2X0
Z3X0
Z4X0
Z5X0
Z6X0
Z7X0
Z8X0
Z9X0
ZAX0
ZBX0
ZCX0
ZDX0
ZFX0

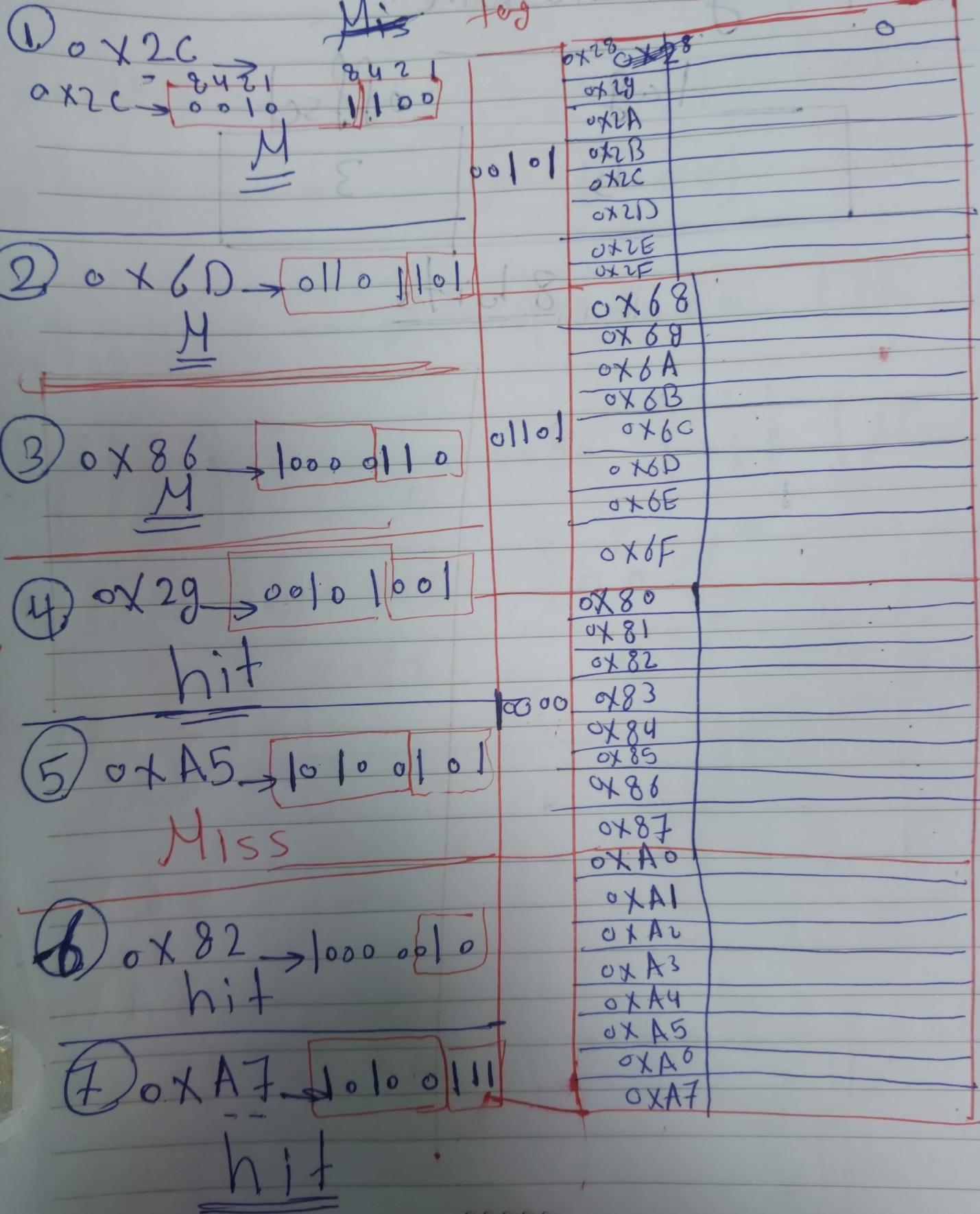
11100001 ← 88X0
fid
10101010 ← 2A40
221M

01000001 ← 58X0
fid

11100101 ← FAX0
fid

DATE //

OBJECT

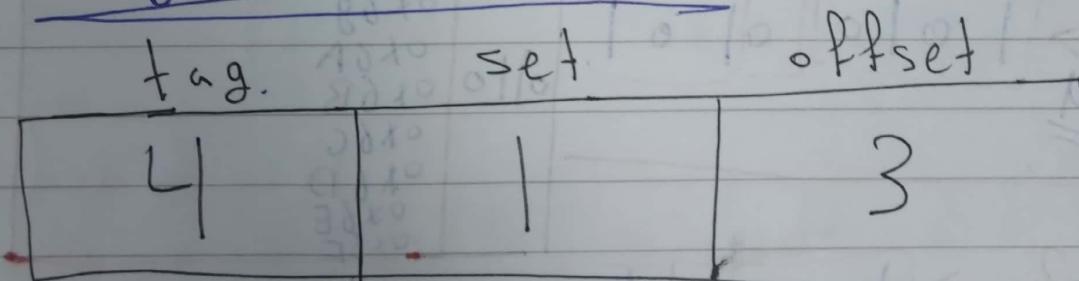


- DATE / / OBJECT
- ⑧ $0x68 \rightarrow$ [0 1 1 0 1] [0 0 0] hit
- ⑨ $0x80 \rightarrow$ [1 0 0 0 0] [0 0 0 0] hit
- ⑩ $0x2B \rightarrow$ [0 0 1 0 1] [0 0 1] hit

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

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

2 way set associative:



8 bit

$$\text{No. of sets} = \frac{4}{2} = 2 \rightarrow 2$$

DATE / /

OBJECT

8421 8421
0x2C → 10010 {1100}

M

S → 0010 1000
0x28

E → 0010 1111
0x2F

0x6D → H 0110 {1101}

M

0x86 → 1000 0110

0x29 → 0010 1001

H

0xA5 → 1010 {0101}

M

0x82 → 1000 0010 → H

0xA7 → 1010 {0111} → H

0x68 → 0110 1000 → H

0x80 → 1000 0000 → H

SAGDA

tag

0x80

0x81

0x82

0x83

0x84

0x85

0x86

0x87

0xA1

0xA2

0xA3

0xA4

0xA5

0xA6

0xA7

0x28

0x29

0x2A

0x2B

0x2C

0x2D

0x2E

0x2F

0x68

0x69

0x6A

0x6B

0x6C

0x6D

0x6E

0x6F

b0

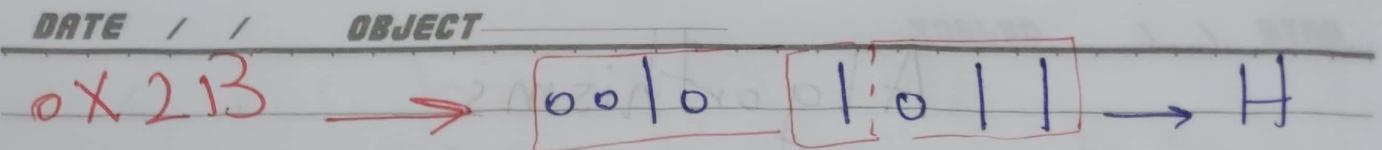
set0

b1

b2

set1

b3



$$\text{hitratio} = 6/10 = 60\%$$

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

$$\text{EAT} = \text{hit} \times \text{Access}_{\text{MainMemory}} + (1 - \text{H}) \times \text{Access}_{\text{Cache}}$$

Access

Main Memory

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

= or

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

$$= 15 \text{ nsec}$$

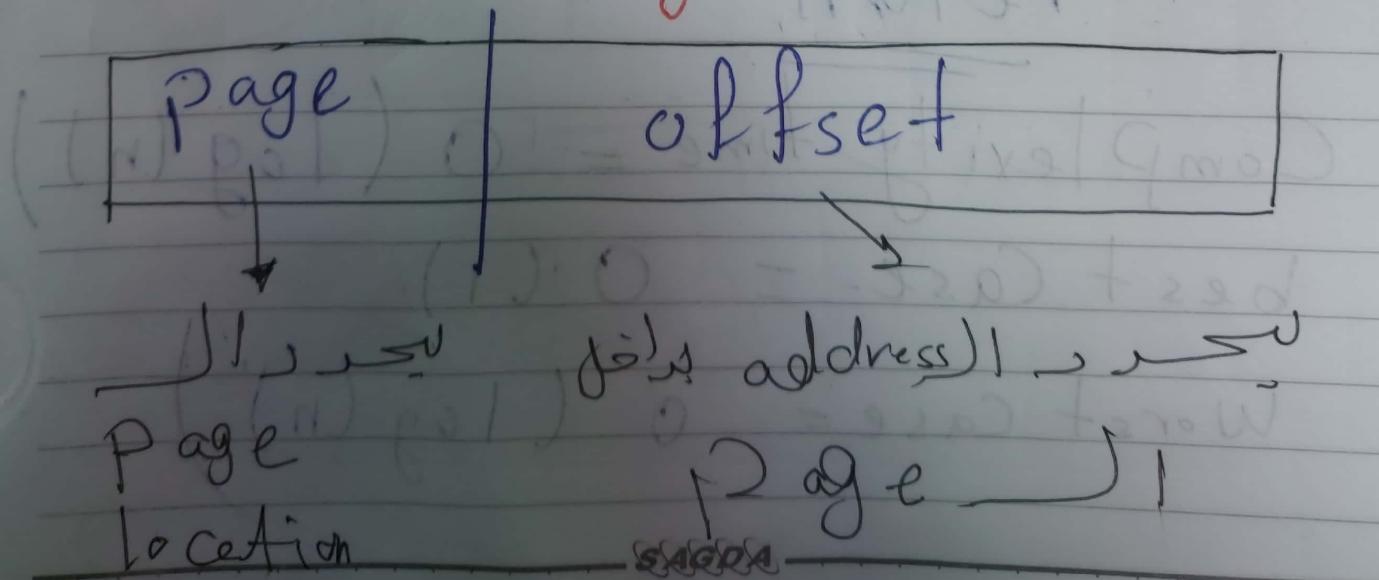
Virtual Memory :-

* Cache Memory enhances performance by providing Memory access speed.

* Virtual Memory enhance Performance by providing greater Memory Capacity.

* Portion of disk drive serves as extension of Main Memory.

Virtual Memory



- * Physical address is the actual Memory address of physical Memory.
- * Programme Create virtual address that are mapped to physical address by Memory Manager.

→ Main Memory and virtual Memory are divided into equal size.

* Physical address.

Frame	offset
-------	--------

DATE / /

OBJECT

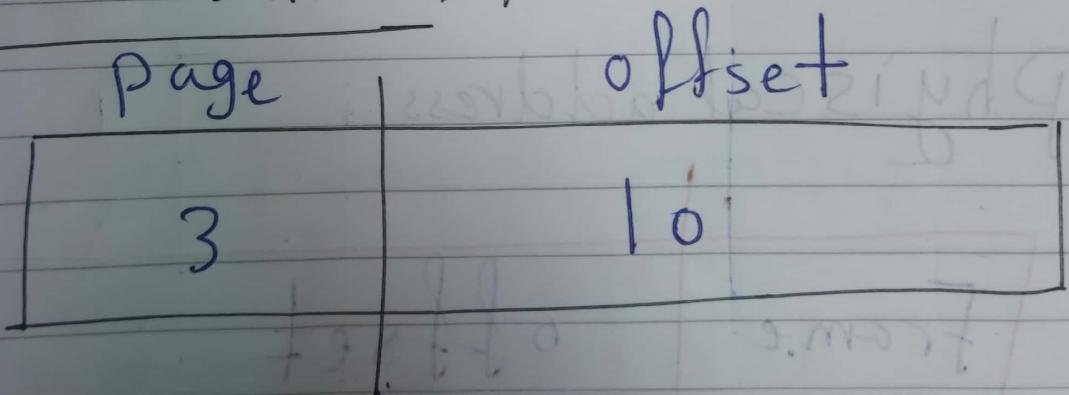
Example 6.5:

$$\text{Virtual address} = 8 \text{ K} \rightarrow 2^3 \cdot 2^{10} = 2^{13}$$

$$\text{Physical address} = 4 \text{ K}$$

$$\rightarrow \text{no. of virtual pages} = \frac{8 \text{ K}}{1 \text{ K}} = \\ = \frac{2^3 \cdot 2^{10}}{2^{10}} = 2^3 \rightarrow 8 \text{ virtual pages}$$

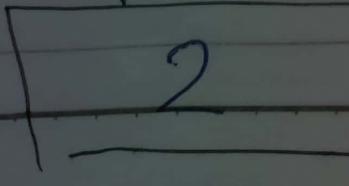
virtual address ??



13 bit

Physical address

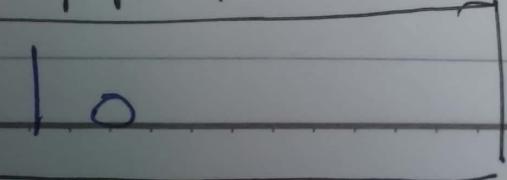
frame



SAGRA

offset

12 bit



DATE / / OBJECT

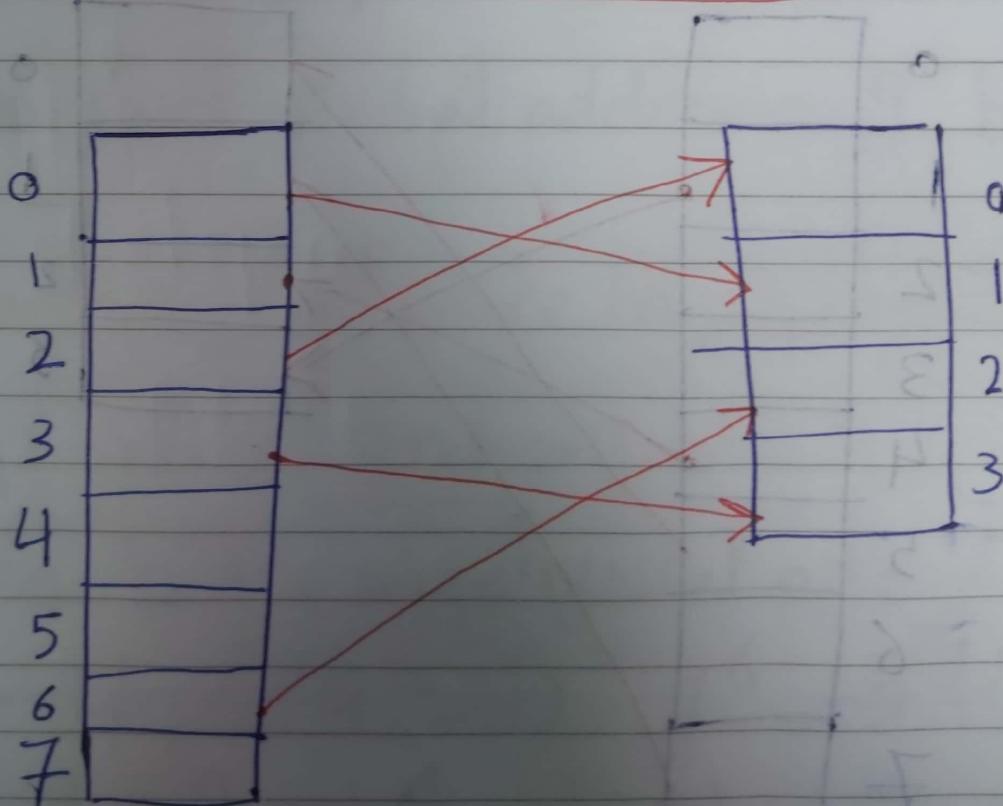
Exercise (sheet 1).

P1

18

	Frame	valid bit
0	1	1
1	-	0
2	0	1
3	3	1
4	-	0
5	-	0
6	2	1
7	-	0

Ans



DATE //

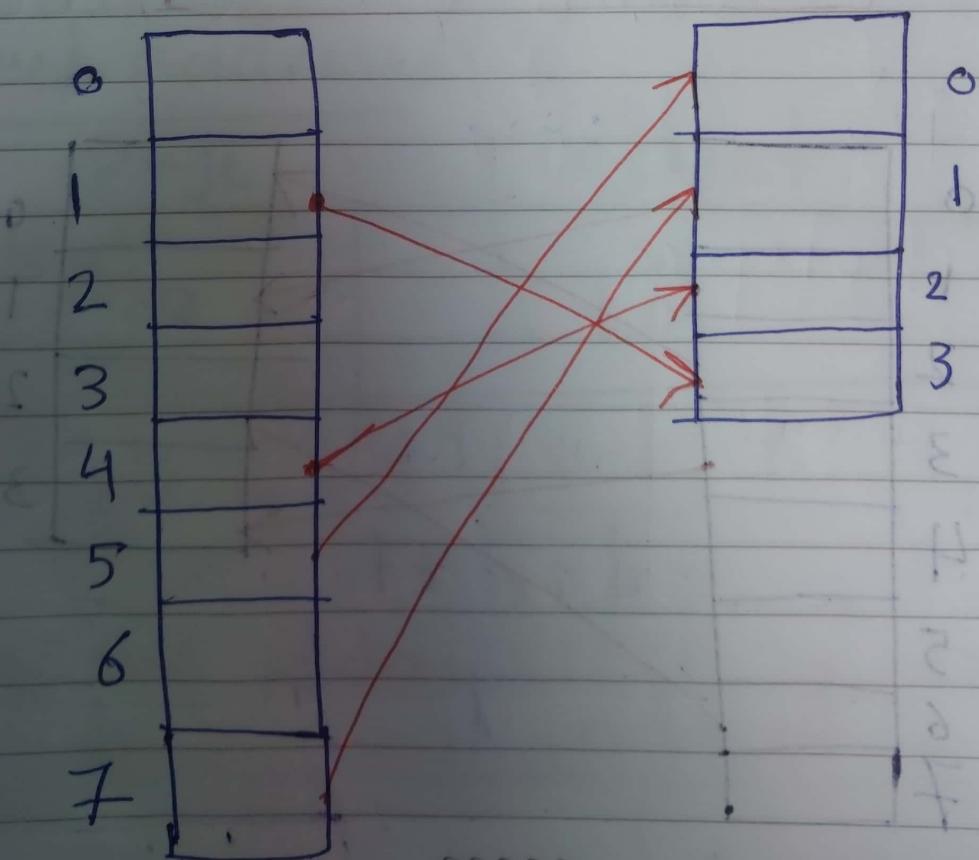
OBJECT

(1) Frame) TERM 3
Exercise

1g

81

Frame	valid bit
0	0
1	1
2	0
3	0
4	1
5	1
6	0
7	1



SAGDA

DATE
20

OBJECT

virtual Memory address with \rightarrow 8 Virtual Pages
 \rightarrow 64 byte each size.

\rightarrow 4 Page Frame

a) how many bits are in a virtual Memory?

Ans:-

No. of bits in virtual address

$$= 8 \cdot 64 = 2^3 \cdot 2^6 = 2^{9}$$

bits of virtual address = 9 bits.

b) how many bits are in a physical address?

Ans:-

No. of bits in physical address

$$= 4 \cdot 64 = 2^2 \cdot 2^6 = 2^8$$

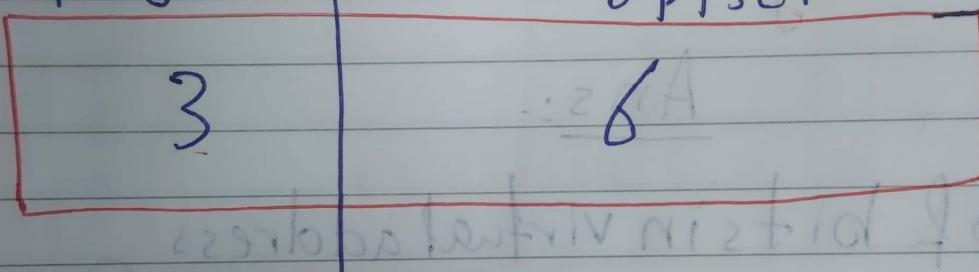
bits of physical address = 8 bits.

DATE / / OBJECT / /

c) What is the physical address
to the following address?

1) $0x00$.

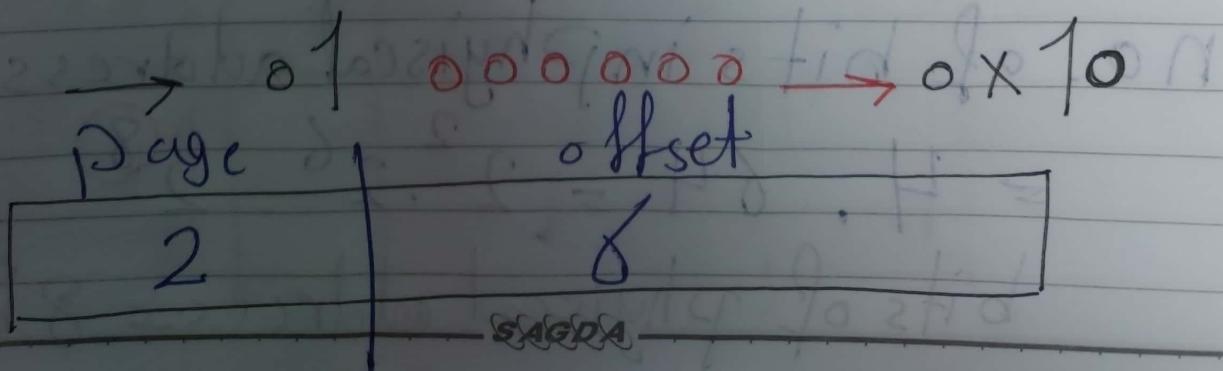
Virtual page address
Page | offset



$0x00 \rightarrow$ [0 0000 . 80000]
Page | offset

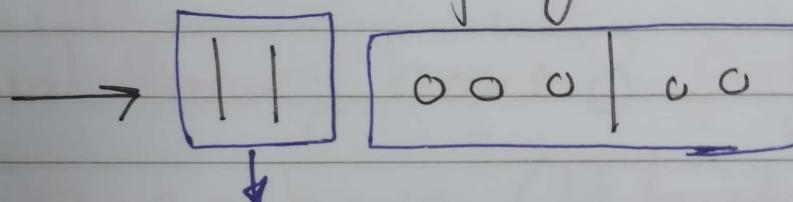
in page o map to Frame 1

to generate physical address.



DATE / / OBJECT
 ii) $0x44 \rightarrow$ [Page | Offset]
 Page 1 | offset 4
 map to Frame 3

the address in physical Memory.



iii) $0xC2 \rightarrow$ [Page | Offset]
 Page 3 | offset 2
 map to frame 0.
 it will generate. 00 00 0010

→ $0x02$

IV) $0x80 \rightarrow$ [Page | Offset]
 Page 2 | offset 0
 map to frame 1

Page 2 not | 000000
 map to any frame. → ~~0x80~~
 SAGDA

Example (20)

Virtual Memory

a) How many bits are in virtual Memory?

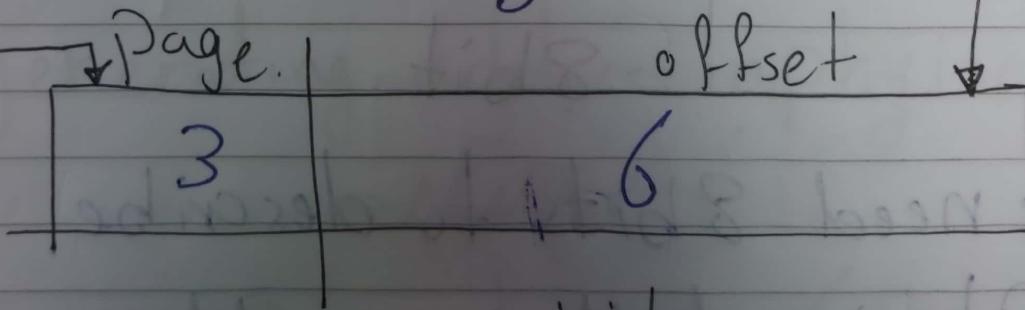
→ Virtual Memory have 8 pages $\rightarrow 2^3$

→ each page have 64 bytes $\rightarrow 2^6$

Total size of virtual memory =

$$8 \cdot 64 = 2^3 \cdot 2^6 = 2^9 \text{ bytes.}$$

We need 9 bits to describe virtual
Memory address.



9 bits

b) How many bits are in physical address? (2)

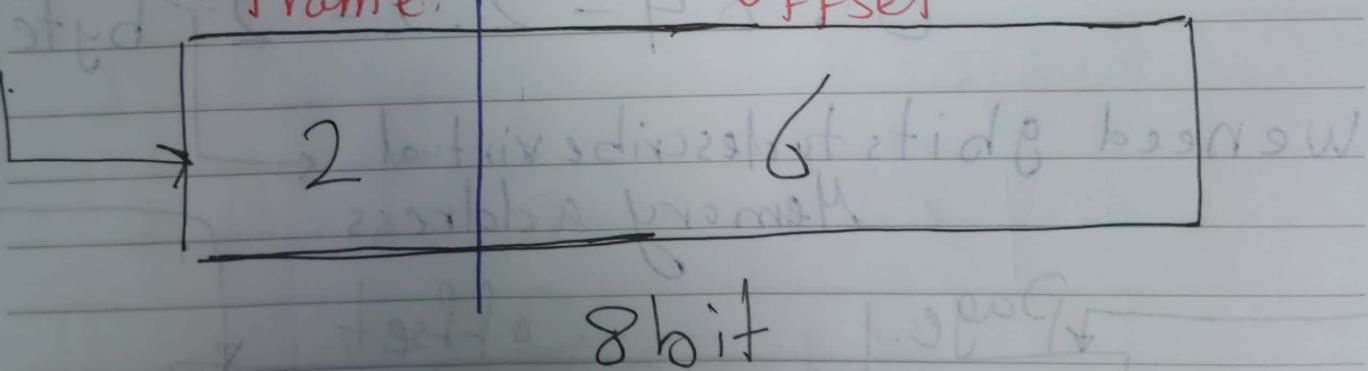
* We have 4 Page Frames in physical Memory (2)

* Page size = Frame size.

Total size in physical memory:

$$= 4 \cdot 64 = 2^2 \cdot 2^6 = 2^8 \text{ bytes.}$$

frame. | offset

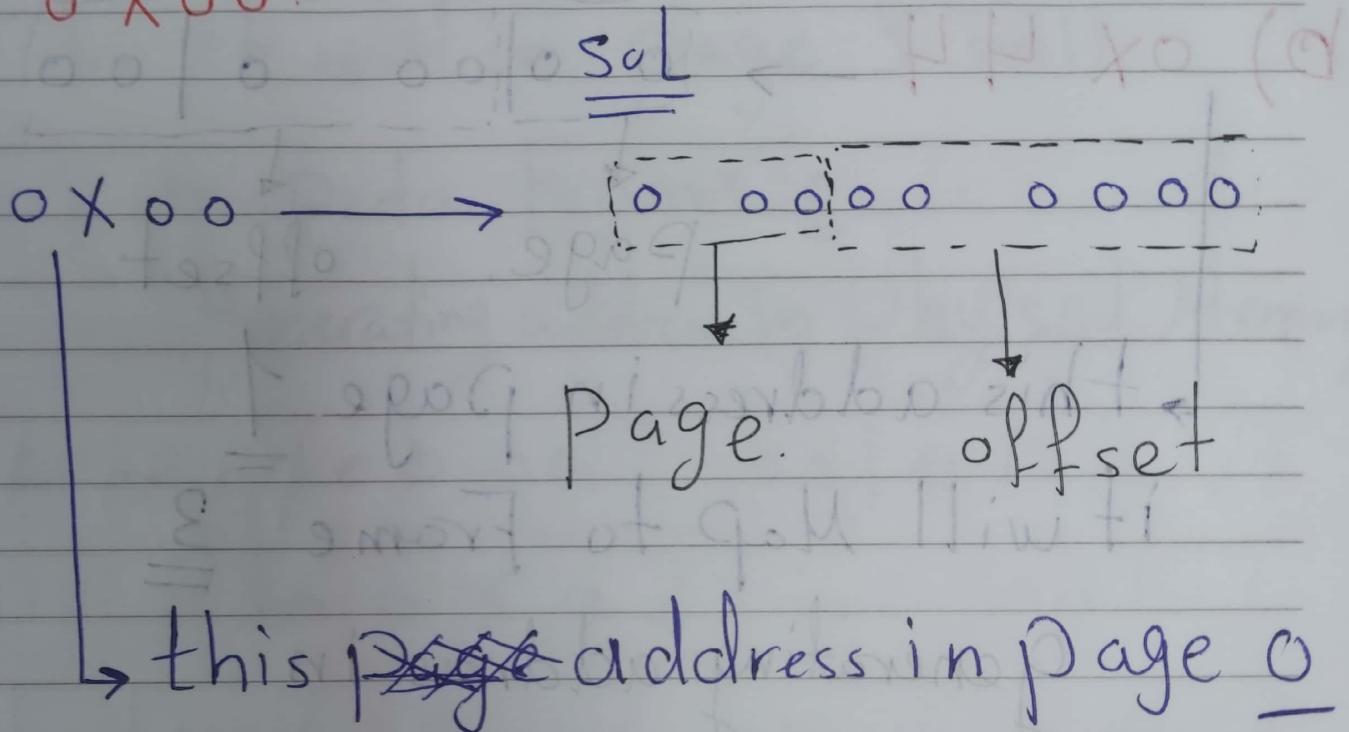


* We need 8 bits to describe

Physical Memory address.

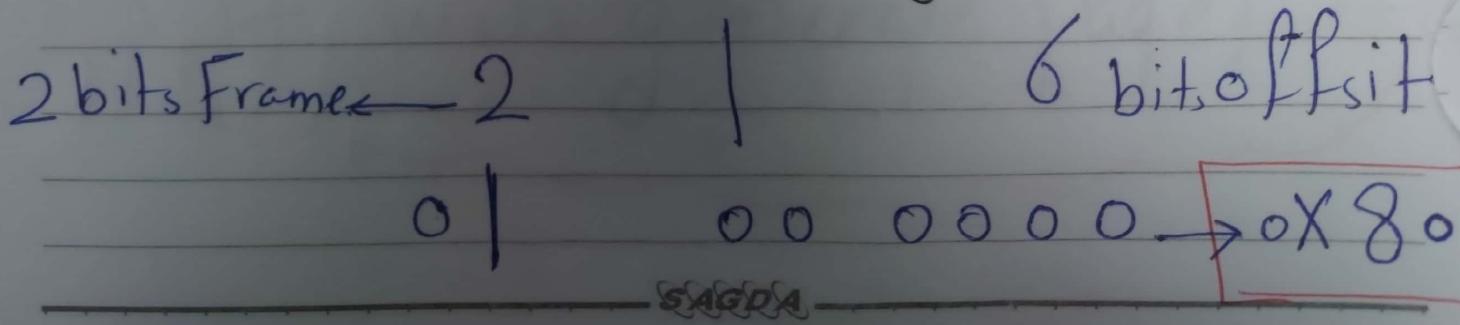
DATE / / OBJECT
c) What physical address Correspond to the Following virtual address ?

a) 0x00.



Page 0 map to Frame 1

* generating address in physical memory.



DATE //

OBJECT

* 0x00 in Vm $\xrightarrow{\text{map to}}$ 0x80 in PM

b) 0x44 \rightarrow [020]00 0100
↓ ↓
Page. offset

↳ this address in page 1
it will Map to Frame 3

generating address in it.
Physical Memory

↓ ↓ ↓
11 00 0100
→ 0xC4

c) $0xC2 \rightarrow 0|1100\ 0010$

\downarrow \downarrow
Page offset

it ~~will~~ in page 3 will

map to Frame $0_{valid\ bit}$

generating address in Physical Memory

$0|00000100|0$

$\rightarrow 0x02$

d) $0x80 \rightarrow 0|000\ 0000$

\downarrow \downarrow
Page offset

bit in Page2 where valid bit = 0

if will generate PageFault