People's Democratic Republic of Algeria
Ministry of higher education and scientific research
University of Mohamed Boudiaf - M'sila

Faculty of Mathematics and Computer Science
Department of Computer Science

2nd Year License (2L)

Operating Systems 1 (OS 1)

Semester : 04

2025/2026

Directed by

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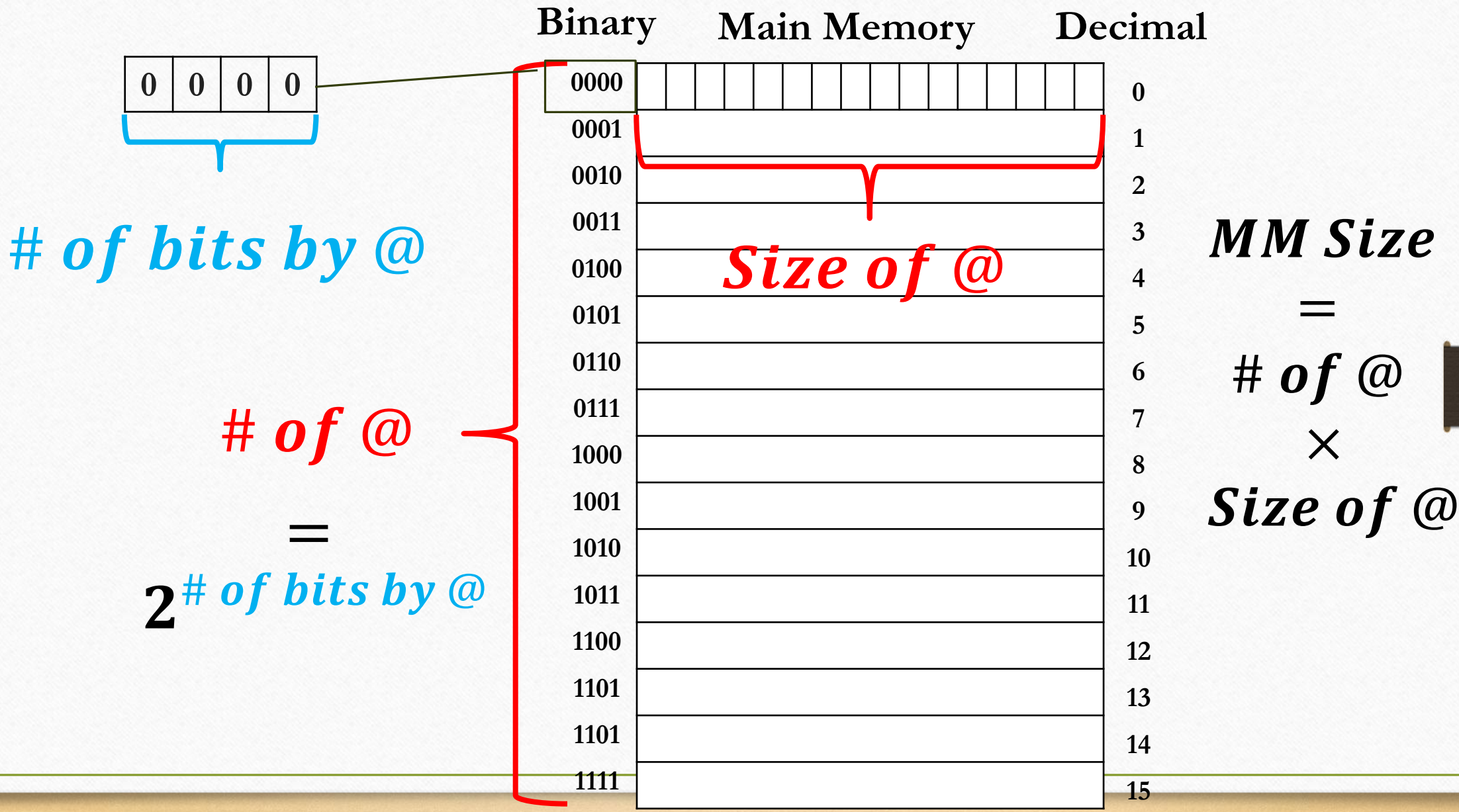
- In case of problems or difficulties, please contact me or your TD / TP teacher.
- We are at your disposal to help you

CHAPTER 5

Memory Management


Binary
Main Memory
Decimal
0 0 0 0
0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1101
1111
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
# of bits by @
Size of @
of @
=
2^(# of bits by @)
MM Size
=
of @
×
Size of @

$$MM\ Size = \#\ of\ @ \times Size\ of\ @$$

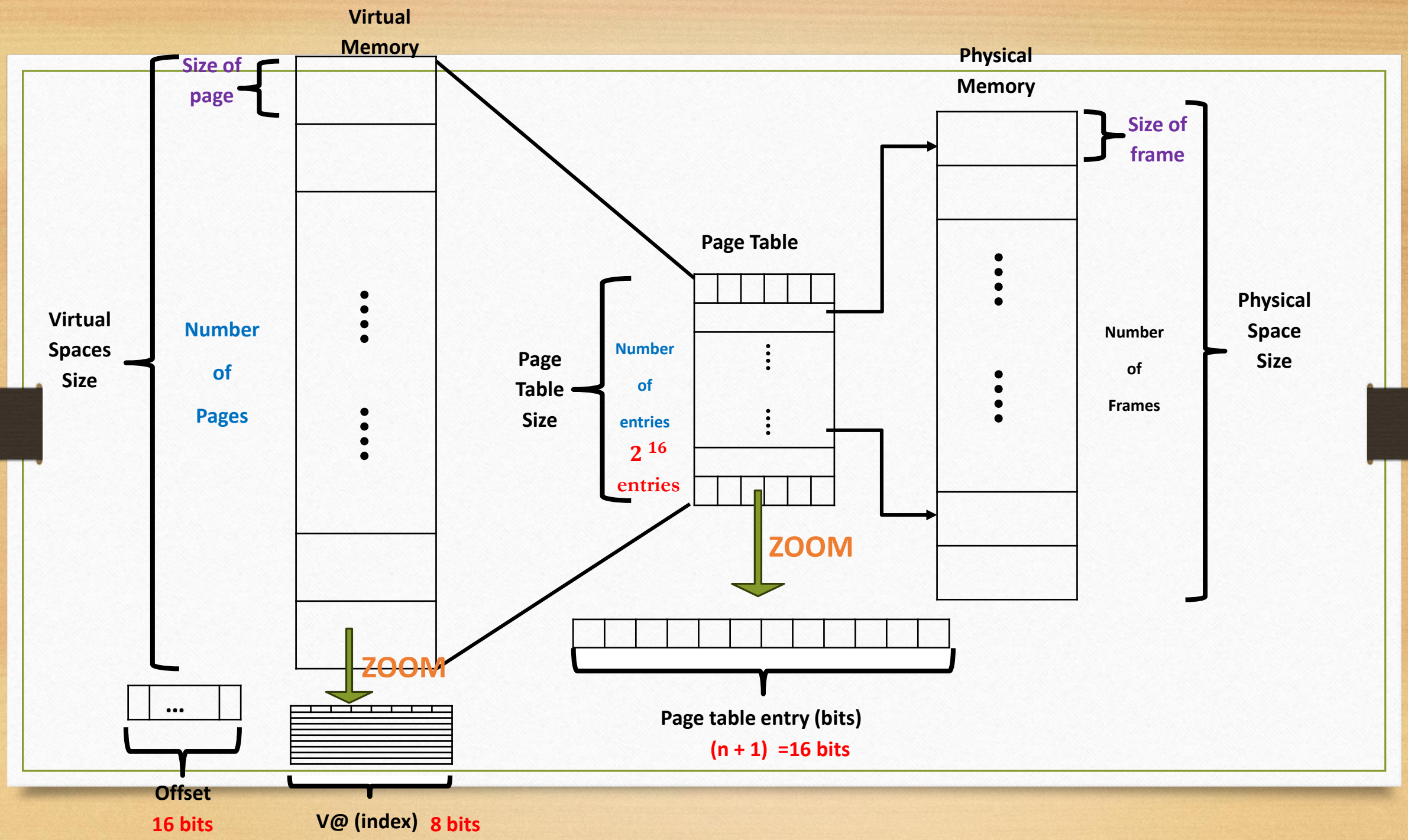
$$\#\ of\ bits\ by\ @ = log_2(\#\ of\ @)$$

$$\#\ of\ @ = 2^{\#\ of\ bits\ by\ @}$$

Exercise V.9

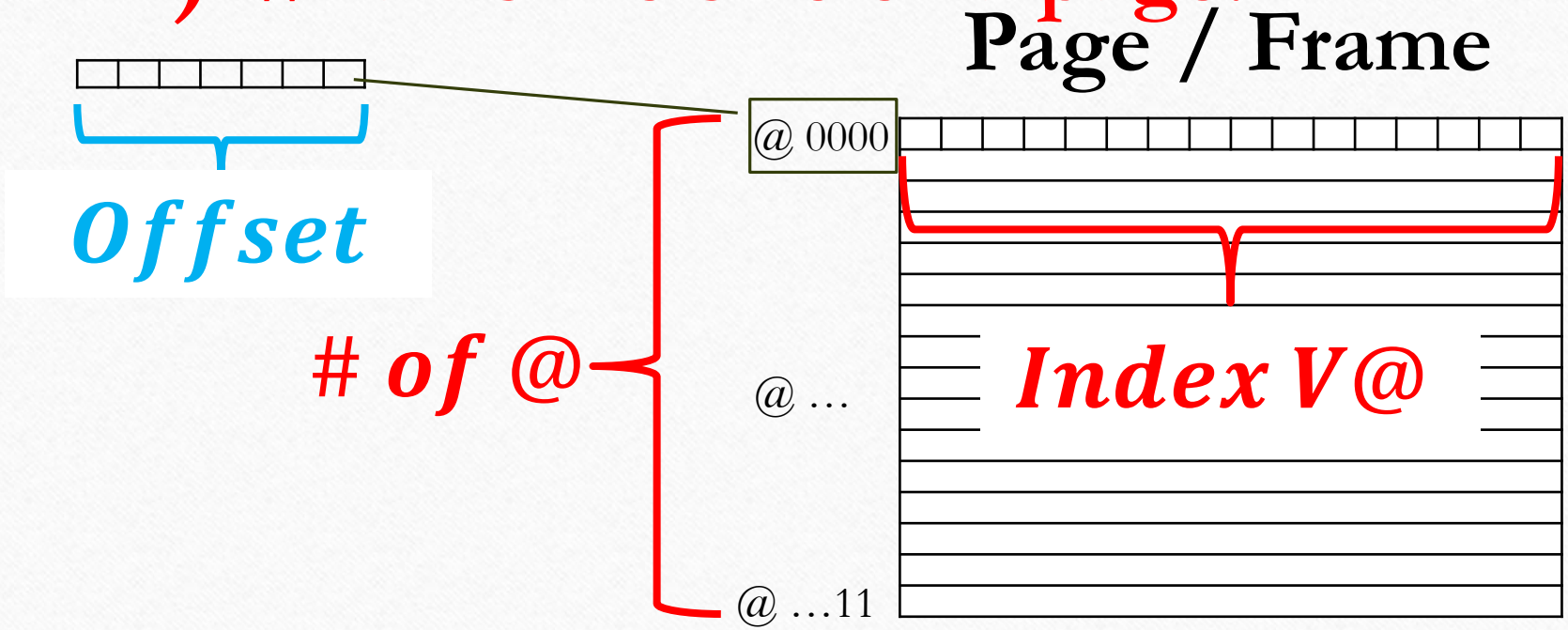
Consider a system using paging technology and having the following characteristics:

- A page table with **2 16 entries** $\#\ of\ entries\ in\ PT = 2^{16}\ Entries$
- Each page table entry is coded on **16 bits**. An entry contains a page frame number and a presence/absence bit. $Size\ of\ a\ PT\ entry = 16\ bits$
- The offset (displacement) is coded on **16 bits** $Offset = 16\ bits$
- A virtual address is indexed by **1 Byte** $Index\ Virtual\ @ = 1\ byte$
- Answer the following questions, always justifying your answer:


Virtual Memory
Size of page
Virtual Spaces Size
Number of Pages
Offset
16 bits
V@ (index) 8 bits
ZOOM
Page Table
Page Table Size
Number of entries
2 16 entries
ZOOM
Page table entry (bits)
(n + 1) =16 bits
Physical Memory
Size of frame
Number of Frames
Physical Space Size

Exercise V.9

1) What is the size of a page?



$$\textbf{Page Size} = \#\ \textbf{of}\ @ \times \textbf{Size of}\ @$$
$$= 2^{(offset)} \times \textbf{Index Virtual}\ @$$

Exercise V.9

1) What is the size of a page?

$$Page\ Size = 2^{(offset)} \times Index\ Virtual\ @$$

$$= 2^{16} \times 1\ Byte = 64\ KB$$

Exercise V.9

2) What is the size of physical memory?

$$Size\ of\ Physical\ memory = \#\ of\ frames \times frame\ size$$

We have :

$$frame\ size = page\ size = 64KB = 2^{16}\ Byte$$

$$\#\ of\ frames = ???$$

Exercise V.8

2) What is the size of physical memory?

$$Size\ of\ a\ PT\ entry = \#\ number\ of\ bits\ to\ code\ a\ frame + 1\ P/A\ \text{bit}$$

$$\#\ number\ of\ bits\ to\ code\ a\ frame = Size\ of\ a\ PT\ entry - 1\ \text{P}/A\ \text{bit}$$

$$\#\ number\ of\ bits\ to\ code\ a\ frame = 16 - 1 = 15\ bits$$

$$\#\ of\ frames = 2^{\#\ number\ of\ bits\ to\ code\ a\ frame} = 2^{15}\ Frames$$

Exercise V.9

2) What is the size of physical memory?

$$Size\ of\ Physical\ memory = \#\ of\ frames \times frame\ size$$

We have :

$$frame\ size = page\ size = 64KB = 2^{16}\ Byte$$

$$\#\ of\ frames = 2^{15}\ Byte$$

$$Size\ of\ Physical\ memory = 2^{15} \times 2^{16}$$

$$= 2^{31} = 2\ GB$$

Exercise V.9

3) What is the size of virtual memory?

- $Size\ of\ virtual\ memory = Nbr\ of\ pages \times page\ size$

- We have :

$$\#\ of\ pages = \#\ of\ entries\ in\ PT = 2^{16}\ pages$$

- $Size\ of\ virtual\ memory = 2^{16} \times 2^{16} = 2^{32} = 4\ GB$

Exercise V.9

4) What is the size of the address bus in bits for this system?

- Address bus size (m) = number of bits required to encode virtual memory
- $\boldsymbol{A\ virtual\ address\ is\ indexed = size\ of\ one\ @\ = 1\ Byte}$
- $$2^m = \frac{Size\ of\ virtual\ memory}{Size\ of\ one\ @} = \frac{2^{32} Byte}{1 Byte} = 2^{32}$$
- $\boldsymbol{\Rightarrow m = 32\ bits}$

Exercise V.9

6) Considering the first eight entries of the page table represented by the following table, give the logical addresses corresponding to the physical addresses **33792** and **66048**.

Exercise V.9

Frame Number	Page Number	Presence/Absence Bit
7	0	0
6	0	0
5	0	1
4	1	1
3	0	0
2	0	0
1	2	1
0	3	1

Exercise V.9

- Logical @ = (# of Pages, Offset)
- Physical @ = (# of Frames, Offset)
- We have : $Page\ Size = 2^{16} = 65536\ Byte$
- **We use the following calculation rule:**

Physical @	Frame/Page Size
Offset	# of Frames

Logical @	Frame/Page Size
Offset	# of Pages

Exercise V.9

- $Physical\ @ = 33792$

33792	65536
33792	0

- $\#\ of\ Frames = 0 \xrightarrow{In\ Page\ Table}$ P/A bit = 1,

$\Rightarrow \#\ of\ Pages = 3$

- $Offset = 33792$

- $\rightarrow Logical\ @ = 3 \times 65536 + 33792 = 230400$

Exercise V.9

- $Physical\ @ = 66048$

66048	65536
512	1

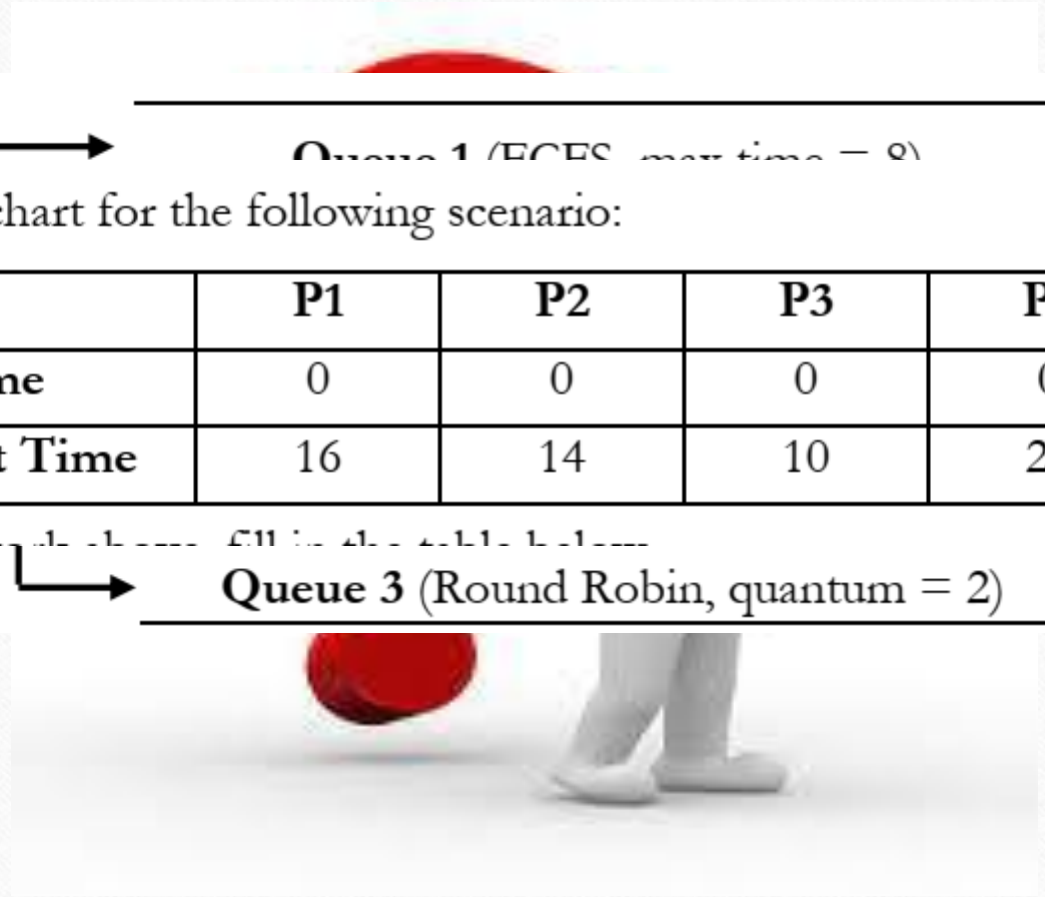
- $\#\ of\ Frames = 1 \xrightarrow{In\ Page\ Table}$ P/A bit = 1,

$\Rightarrow \#\ of\ Pages = 2$

- $Offset = 512$

- $\rightarrow Logical\ @ = 2 \times 65536 + 512 = 131584$

Questions ?



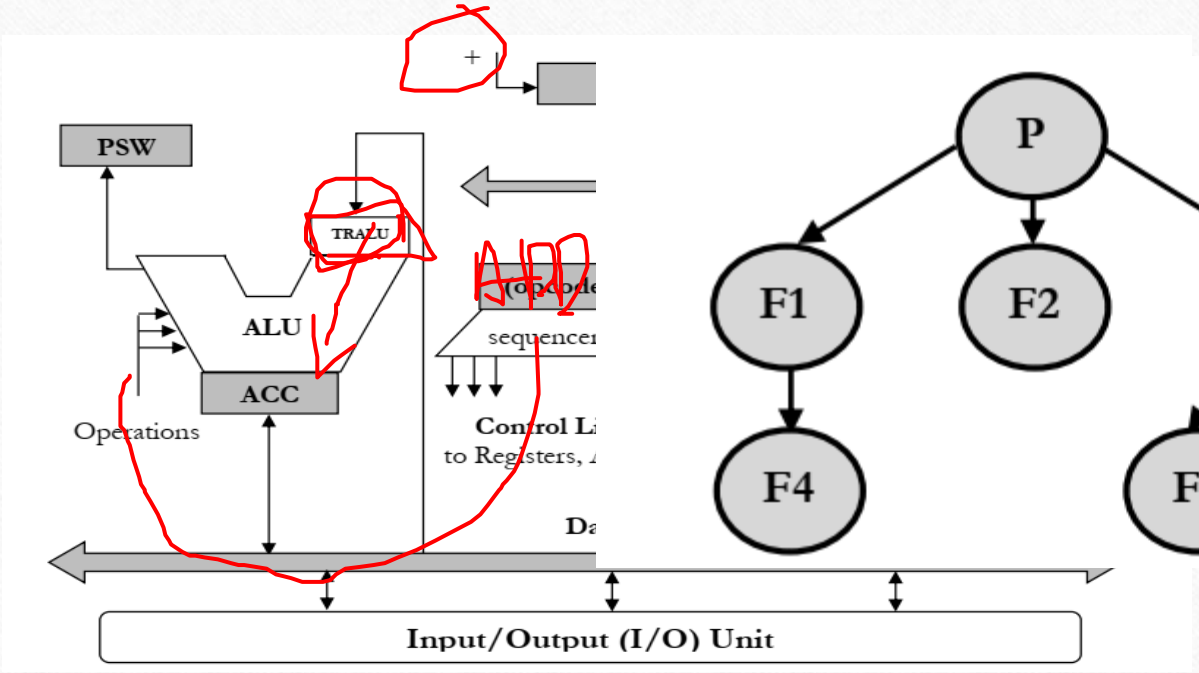
High Priority → Queue 1 (FCFS, max time = 8) →

Q2) Give the Gantt chart for the following scenario:

Process	P1	P2	P3	P4	P5
Arrival Time	0	0	0	0	0
CPU Burst Time	16	14	10	20	06

Low Priority → **Queue 3** (Round Robin, quantum = 2) →

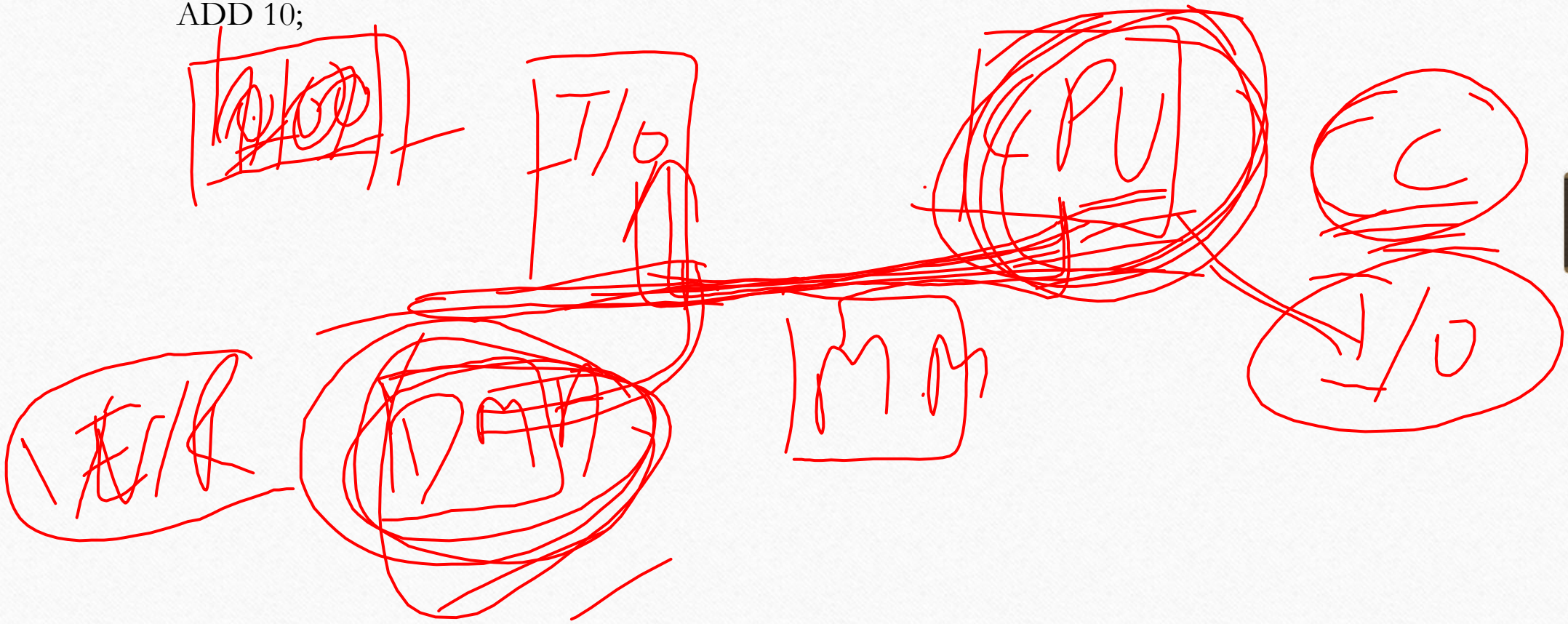
Questions ?

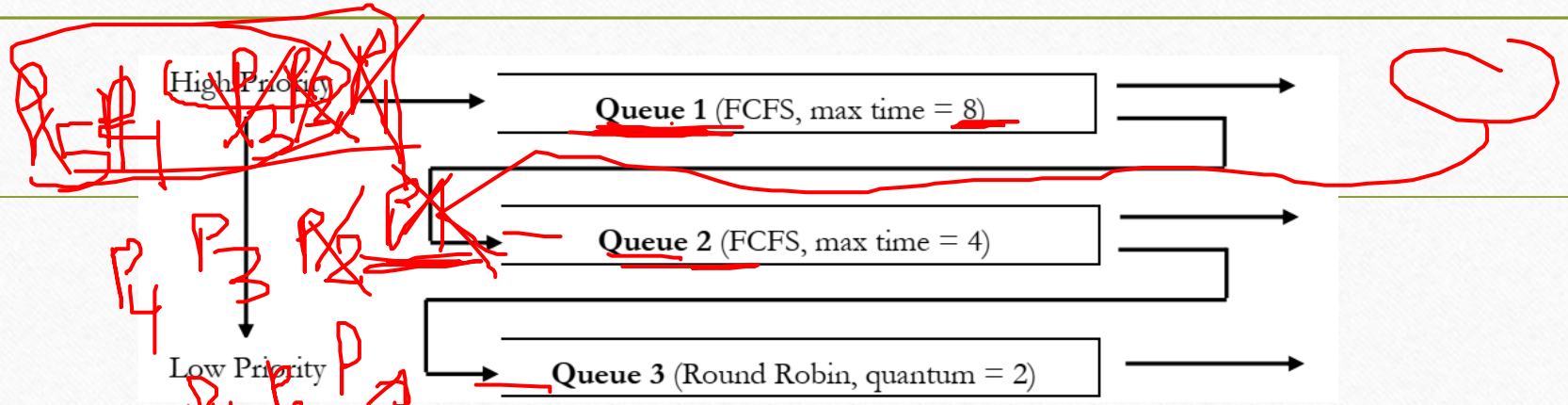

PSW
TRALU
ALU
ACC
Operations
Input/Output (I/O) Unit

P
F1
F2
F3
F4
F5
F6

Questions ?

ADD 10;





Q2) Give the Gantt chart for the following scenario:

Process	P1	P2	P3	P4	P5
Arrival Time	0	0	0	0	0
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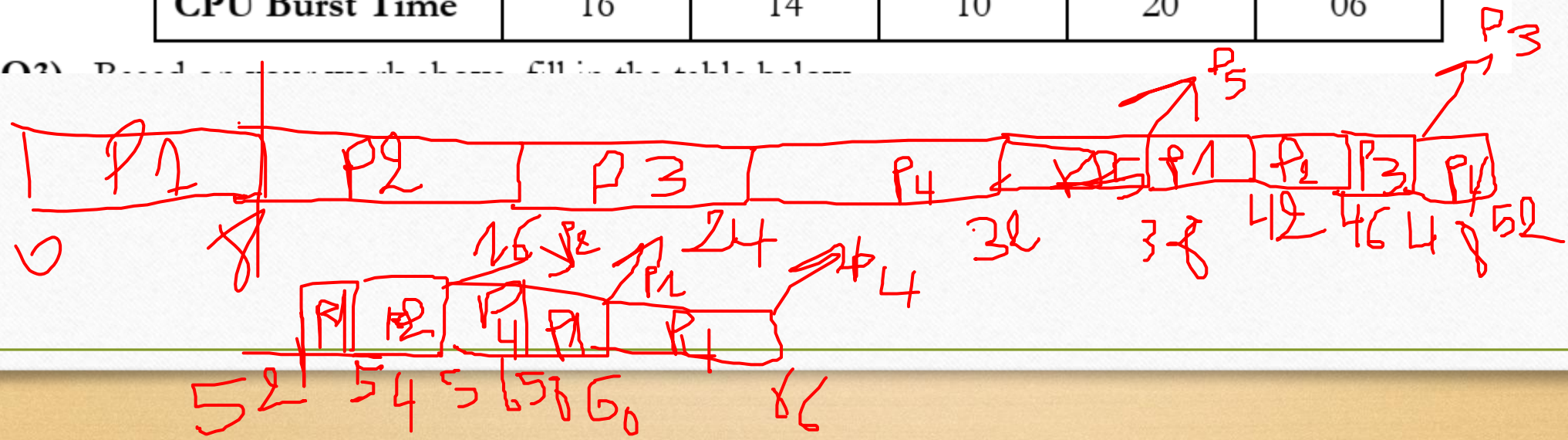

Questions ?

```
1 : # include < unistd.h>
2 : int main ()
3 : {
4 : if( fork ())
5 :     fork () && ( fork () || ( fork () && fork ()));
6 : else
7 :     fork ();
8 : return 0;
9 : }
```