MKUB, Level: 2LMD **Module: Operating Systems 1** **Duration:45 min** **04/05/ 2023**

Test 2 Solution

Exercise 1 (6 marks=1+1+1+1+2):

1. How many page frames are in physical memory?

Number of page frames = Physical mem size/frame size= $2*2^{30} / 2^{6} * 2^{10} = 2^{15}$ frame

2. What is the bit size of a page table entry?

Size of a PT input = number of bits to encode a frame + 1 presence bit

= 15 + 1 = 16 bits

3. What is the number of entries in the page table?

Number of entries in the PT = Size of the PT / size of an entry in the PT= 128 Ko / 16

$= 2_7 * 2^{10} * 2_3 / 2_4 = 2^{16}$ entries

4. What is the size of the virtual memory of this architecture?

Virtual mem size = number of pages * size of a page

= Number of entries in the PT * size of a page

$= 2^{16} * 2^{16} = 2_{32}$ octets = 4Go

5. Consider the following two logical addresses expressed in decimal: 1024 and 65540.
Give the corresponding physical addresses (expressed in decimal).

logical @= 1024

page size = 2^{16} = 65536; page n° = 0 ; offset = 1024; frame n° = 0

physical @ = 0*65536 + 1024 = 1024

logical @= 65540 ; Taille page = 2^{16} = 65536; page n° = 1; offset = 4

For page 1, the presence/absence bit =0, hence the page is not loaded into memory.

We cannot know the physical address.

Exercise 2 (6 marks=1+1+1+1+1+1):

1. Perform the access sequence with the replacement strategies FIFO, Optimal, and LRU with a memory capacity of 4 frames, and repeat FIFO with 5 frames. Calculate page fault and page fault rate in each case.

1 3 5 4 2 4 3 2 1 0 5 3 5 0 4 3 5 4 3 2 1 3 4 5

a. FIFO (with 4 frames)

Requests:	1	3	5	4	2	4	3	2	1	0	5	3	5	0	4	3	5	4	3	2	1	3	4	5
Page 1:	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	5
Page 2:		3	3	3	3	3	3	3	1	1	1	1	1	1	4	4	4	4	4	4	4	4	4	4
Page 3:			5	5	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2
Page 4:				4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	1	1	1	1

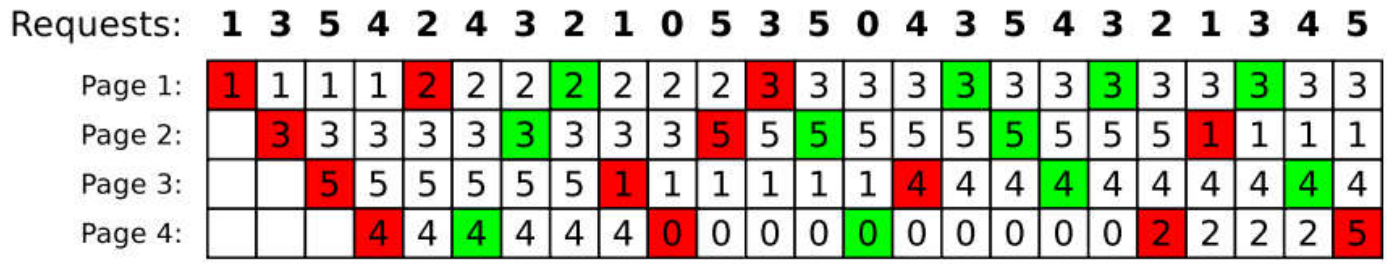
page fault = 13 , page fault rate=13\24 =54%

b. FIFO (with 5 frames)

Requests:	1	3	5	4	2	4	3	2	1	0	5	3	5	0	4	3	5	4	3	2	1	3	4	5
Page 1:	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Page 2:		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
Page 3:			5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	3	3
Page 4:				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5
Page 5:					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

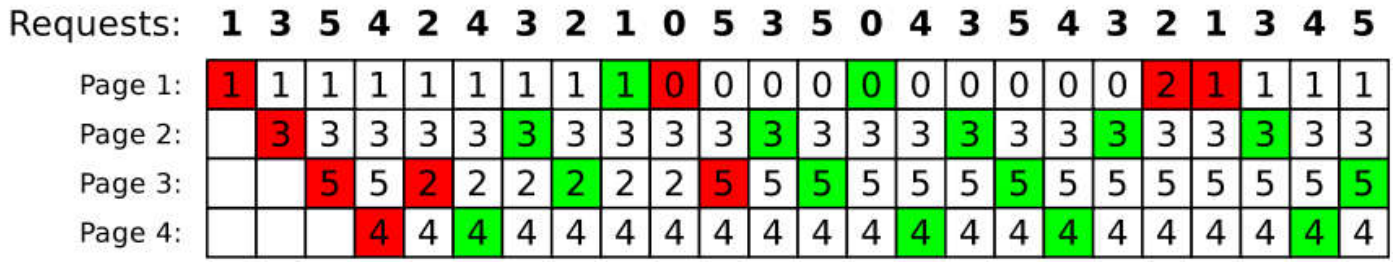
page fault = 9 , page fault rate=9\24 =37%

c. LRU (with 4 frames)



page fault = 13; page fault rate =13\24=54%

d. Optimal (with 4 frames)



page fault = 9, page fault rate =9\24=37%

2. What is the key message of Belady's anomaly?

FIFO result in worse results for certain access sequences with a bigger memory.

3. Why is it impossible to implement the optimal replacement strategy?

Because it is not possible to predict the future and therefore the future request sequence is unknown.