

# Assignment

## Virtual Memory

9.21 Consider the following page reference string:

7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1.

Assuming demand paging with three frames, how many page faults would occur for the following replacement algorithms?

- i) LRU replacement
- ii) FIFO replacement
- iii) Optimal replacement

Ans (i) LRU Replacement

7	2	3	1	2	5	3	4	6	7	7	1	0	5	4	6	2	3	0	1
7	7	7	1	1	1	8	3	3	7	7	7	7	5	5	5	2	2	2	1
2	2	2	2	2	2	2	4	4	4	4	1	1	1	4	4	4	3	3	3
3	3	3	5	5	5	6	6	6	6	0	0	0	6	6	6	0	0		
x	x	x	x	↑	x	x	x	x	x	↑	x	x	x	x	x	x	x	x	x

∴ Number of page faults = 18

(ii) FIFO replacement

7 2 3 1 2 5 3 4 6 7 7 1 0 5 4 6 2 3 0 1

7 7 7 1 1 1 1 1 6 6 6 6 0 0 0 6 6 6 0 0

2 2 2 2 5 5 5 5 7 7 7 7 5 5 5 2 2 2 1

3 3 3 3 3 4 4 4 4 1 1 1 4 4 4 3 3 3

x x x x ↑ x ↑ x x x ↑ x x x x x x x x x



∴ Number of page faults = 17

(iii) Optimal Replacement

7	2	3	1	2	5	3	4	6	7	7	1	0	5	4	6	2	3	0	1
7	7	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	5	5	5	5	5	5	5	5	5	5	4	6	2	3	3	3
3	3	3	3	3	3	4	6	7	7	7	0	0	0	0	0	0	0	0	0
x	x	x	x	↑	x	↑	x	x	x	↑	↑	x	↑	x	x	x	x	↑	↑

∴ Number of page faults = 13.

9.3 Consider the page table shown in Fig 9.30 for a system with 12-bit virtual and physical addresses and with 256-byte pages. The list of free page frames is D, E, F (that is, D is at the head of the list, E is second, and F is last).

Page	Page Frame
0	-
1	2
2	C
3	A
4	-
5	4
6	3
7	-
8	B
9	0

Fig 9.30 - Page table



Convert the following virtual addresses to their equivalent physical addresses in hexadecimal. All numbers are given in hexadecimal. (A dash for a page frame indicates that the page is not in memory.)

(i) 9EF

(ii) 111

(iii) 700

(iv) OFF

Ans

Size of virtual / physical address space =  $2^{12}$

= 4096 bytes

Page size =  $2^8 = 256$  bytes

Therefore,  $12 - 8 = 4$  high-order bits of logical address represent page number and 8 low-order bits represent page offset.

(i) 9EF → corresponds to page 9

Physical address = 0EF

(ii) 111 → corresponds to page 1

Physical address = 211

(iii) 700 → corresponds to page 7

Read page 7 to free page frame D

Physical address = D00

(iv) OFF → corresponds to page 0

Read page 0 to free page frame E

Physical address = EFF