1. A computer has four page frames. The time loaded, time of last access, and reference bit for each page are as shown below (the times are in clock ticks):

| Page | Loaded | Last Access | R |
| --- | --- | --- | --- |
| 0 | 126 | 279 | 0 |
| 1 | 230 | 260 | 0 |
| 2 | 120 | 272 | 1 |
| 3 | 160 | 280 | 1 |

In each case, give a brief explanation to justify your answer.

* 1. Which page will FIFO replace?

- ANS : Page 2 is FIFO replace because it is loaded at 120 (First in). Th page that have the lowest number of loaded is FIFO replace

b) Which page will Second Chance replace?

- ANS : Page 0 is Second Chance replace because it is loaded at 126 and its reference bit is 0. Reference bit equal to zero means that page is unused. If reference bit equal to 1, even though it has the lowest loaded, but it won’t be selected.

c) Which page will LRU replace?

- ANS : Page 1 is LRU replace because it is accessed at 260 (Least Recently). The page that have the lowest accessed means that it least recently used.

2. For each of the page replacement policies listed below, calculate the total number of page faults encountered when referencing the following pages :   
0 1 6 0 3 4 0 1 0 3 4 6 3 4  
Assume the availability of 4 page frames, where initially they are all empty.

a) FIFO

Reference string

0 1 6 0 3 4 0 1 0 3 4 6 3 4

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 |
|  | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
|  |  | 6 | 6 | 6 | 6 | 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
|  |  |  |  | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 6 | 6 | 6 |
| F | F | F | H | F | F | F | F | H | H | H | F | F | F |

Page frames

The total number of page faults is 10.

b) CLOCK

Reference string

0 1 6 0 3 4 0 1 0 3 4 6 3 4

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0(0) | 0(0) | 0(0) | 0(1) | 0(1) | 0(0) | 0(1) | 0(0) | 0(1) | 0(1) | 0(1) | 0(0) | 0(0) | 0(0) |
|  | 1(0) | 1(0) | 1(0) | 1(0) | 4(0) | 4(0) | 4(0) | 4(0) | 4(0) | 4(1) | 4(0) | 4(0) | 4(1) |
|  |  | 6(0) | 6(0) | 6(0) | 6(0) | 6(0) | 1(0) | 1(0) | 1(0) | 1(0) | 6(0) | 6(0) | 6(0) |
|  |  |  |  | 3(0) | 3(0) | 3(0) | 3(0) | 3(0) | 3(1) | 3(1) | 3(0) | 3(1) | 3(1) |
| F | F | F | H | F | F | H | F | H | H | H | F | H | H |

Page frames

The total number of page faults is 7.

c) LRU

Reference string

0 1 6 0 3 4 0 1 0 3 4 6 3 4

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0(1) | 0(1) | 0(1) | 0(3) | 0(3) | 0(2) | 0(4) | 0(3) | 0(4) | 0(3) | 0(2) | 0(1) | 0(1) | 0(1) |
|  | 1(2) | 1(2) | 1(1) | 1(1) | 4(4) | 4(3) | 4(2) | 4(2) | 4(1) | 4(4) | 4(3) | 4(2) | 4(4) |
|  |  | 6(3) | 6(2) | 6(2) | 6(1) | 6(1) | 1(4) | 1(3) | 1(2) | 1(1) | 6(4) | 6(3) | 6(2) |
|  |  |  |  | 3(4) | 3(3) | 3(2) | 3(1) | 3(1) | 3(4) | 3(3) | 3(2) | 3(4) | 3(3) |
| F | F | F | H | F | F | H | F | H | H | H | F | H | H |

Page frames

The total number of page faults is 7.

3. Consider a computer system that uses demand paging. Suppose the following time-measured utilizations have been observed:

● CPU utilization 20%

● Swap space disk utilization 97.7%

● Other I/O devices 5%

* 1. What conclusion can you draw from these measurements?

- CPU utilization refers to a computer's usage of processing resources, or the amount of work handled by a CPU. Swap space in Linux is used when the amount of physical memory (RAM) is full. Follow in the question it shows that the system use more on paging in of memory. So, you use a less program it will help program to high performance

(b) Which (if any) of the following is likely to improve CPU utilization? In each case, briefly explain your answer.

(i) Install a faster CPU

- No. A faster CPU will not help because CUP is not the problem. Follow the time-measured utilizations, the problem is because system’s CPU spends a lot of time accessing disk.

(ii) Install a bigger paging disk

- No. Thrashing is more likely caused by the main memory capacity and disk accessing speed. Page disk size is not the problem.

(iii) Increase the degree of multiprogramming

- No. Adding more programs will increase the amount of paging, making the problem worse. All processes might not be able to get their pages in a reasonable speed, and nobody gets to run smoothly.

(iv) Decrease the degree of multiprogramming

- Yes. Decreasing the degree of multiprogramming means more frames per process. It reduces the thrashing. The remaining processes might be able to get their pages in a reasonably fast speed, and get to run smoothly.

(v) Install more main memory

- Yes. Install more memory will reduces the trashing because it has more frame per process.

(vi) Install a faster disk or multiple disks

- Yes. the disk bottleneck is removed by faster response and more throughput to the disks, the CPU will get more data more quickly.

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