|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

1.

FIFO has 17 faults:

LRU has 18 faults:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 3 | 3 | 3 | 7 | 7 | 7 | 7 | 5 | 5 | 5 | 2 | 2 | 2 | 1 |
|  | 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 |

Optimal has 13 faults:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 4 | 6 | 2 | 3 | 3 | 3 |
|  |  | 3 | 3 | 3 | 3 | 3 | 4 | 6 | 7 | 7 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2. a) No, a faster CPU would make the CPU idle more

b) No, size of paging disk does not affect amount of memory used to reduce faults

c) No, each process would have fewer frames and fault rate would increase

d) Yes, each process would have more frames thereby reducing the number of faults

e) Yes, pages can remain resident and do not require paging

f) No, CPU will quickly acquire more data when the bottleneck of the disk is removed

g) Yes, CPU would get data faster

h) No, each process will have fewer frames and the fault rate will increase

3. a) i. Initial value for each counter is 0.

ii. Counters increased when new pages are associated with the frame.

iii. Counters decreased when pages that are associated with the frame are not used anymore.

iv. Page frame with the smaller counter is selected for the replacement. FIFO is used when there is a tie.

b) 13 page faults

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 3 | 4 | 1 | 6 | 7 | 8 | 7 | 8 | 9 | 7 | 8 | 9 | 5 | 4 | 5 | 4 | 2 |
| 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
|  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 |
|  |  | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 7 | 7 | 7 | 7 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
|  |  |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 | 8 | 8 | 4 | 4 | 4 | 2 |

c) 11 page faults

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 3 | 4 | 1 | 6 | 7 | 8 | 7 | 8 | 9 | 7 | 8 | 9 | 5 | 4 | 5 | 4 | 2 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 6 | 6 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
|  | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
|  |  | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 4 | 4 | 4 | 4 |
|  |  |  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |