1. （1）2.4微秒；

（2）80% × 1.2 + (1 – 80%) × 2.4 = 1.44微秒。

1. 由于页长为8KB，页内偏移量需占用虚拟/物理地址的3 + 10 = 13位，

则页表项有2 ^ (48 – 13) = 2 ^ 35个；

同理可得反置页表的页表项为2 ^ (32 – 13) = 2 ^ 19个。

1. FIFO：第3页被换出，因为第3页loaded时间最早；

LRU：第1页被换出，因为第1页的last reference时间最早；

NRU：第1页，因为第1页有R = 0，D = 0（最近未访问也未修改）。

1. （1）由于页面大小为100B，则各个访问地址所在的页号分别为：

10（0），11（0），104（1），170（1），73（0），305（3），180（1），

240（2），244（2），445（4），467（4），366（3）。

页面访问序列为：0，0，1，1，0，3，1，2，2，4，4，3。

（2）FIFO：12次访问有5次缺页，即缺页中断率为5 ÷ 12 = 41.67%；

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 访问 | 0 | 0 | 1 | 1 | 0 | 3 | 1 | 2 | 2 | 4 | 4 | 3 |
| 页框 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
|  |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 |
|  |  |  |  |  | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 缺页 | 是 | 否 | 是 | 否 | 否 | 是 | 否 | 是 | 否 | 是 | 否 | 否 |

LRU：12次访问有6次缺页，即缺页中断率为6 ÷ 12 = 50%。

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 访问 | 0 | 0 | 1 | 1 | 0 | 3 | 1 | 2 | 2 | 4 | 4 | 3 |
| 页框 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
|  |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
|  |  |  |  |  | 3 | 3 | 3 | 3 | 4 | 4 | 4 |
| 缺页 | 是 | 否 | 是 | 否 | 否 | 是 | 否 | 是 | 否 | 是 | 否 | 是 |

1. 由于页面大小为1KB，则页内偏移量在虚拟地址中占10位，页号占6位。

根据页号查找页表，得到相应的页框号，与页内偏移量合并得到物理地址。

（1）（1052）10 =（0000010000011100）2，页号为1，查表得页框号为7。

则物理地址为（0001110000011100）2 =（7196）10。

（2）（2221）10 =（0000100010101101）2，页号为4，

查表发现不在内存，发生缺页中断。

（3）（5499）10 =（0001010101111011）2，页号为5，查表得页框号为0，

则物理地址为（0000000101111011）2 =（379）10。

1. （1）采用OPT策略，如图，缺页异常次数为6次。

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 访 | P1 | P2 | P3 | P1 | P4 | P5 | P1 | P2 | P1 | P4 | P5 | P3 | P4 | P5 |
| 页  框 | P1 | P1 | P1 | P1 | P1 | P1 | P1 | P1 | P1 | P1 | P1 | P3 | P3 | P3 |
|  | P2 | P2 | P2 | P2 | P2 | P2 | P2 | P2 | P2 | P2 | P2 | P2 | P2 |
|  |  | P3 | P3 | P3 | P5 | P5 | P5 | P5 | P5 | P5 | P5 | P5 | P5 |
|  |  |  |  | P4 | P4 | P4 | P4 | P4 | P4 | P4 | P4 | P4 | P4 |
| 缺 | 是 | 是 | 是 | 否 | 是 | 是 | 否 | 否 | 否 | 否 | 否 | 是 | 否 | 否 |

（2）采用FIFO策略，如图，缺页异常次数为10次。

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 访 | P1 | P2 | P3 | P1 | P4 | P5 | P1 | P2 | P1 | P4 | P5 | P3 | P4 | P5 |
| 页  框 | P1 | P1 | P1 | P1 | P1 | P5 | P5 | P5 | P5 | P5 | P5 | P5 | P4 | P4 |
|  | P2 | P2 | P2 | P2 | P2 | P1 | P1 | P1 | P1 | P1 | P1 | P1 | P5 |
|  |  | P3 | P3 | P3 | P3 | P3 | P2 | P2 | P2 | P2 | P2 | P2 | P2 |
|  |  |  |  | P4 | P4 | P4 | P4 | P4 | P4 | P4 | P3 | P3 | P3 |
| 缺 | 是 | 是 | 是 | 否 | 是 | 是 | 是 | 是 | 否 | 否 | 否 | 是 | 是 | 是 |

（3）采用SCR策略，如图，缺页异常次数为10次。

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 访 | P1 | P2 | P3 | P1 | P4 | P5 | P1 | P2 | P1 | P4 | P5 | P3 | P4 | P5 |
| 页  框 | P1 | P1 | P1 | P1 | P1 | P2 | P3 | P4 | P4 | P4 | P4 | P5 | P1 | P2 |
|  | P2 | P2 | P2 | P2 | P3 | P4 | P5 | P5 | P5 | P5 | P1 | P2 | P3 |
|  |  | P3 | P3 | P3 | P4 | P5 | P1 | P1 | P1 | P1 | P2 | P3 | P4 |
|  |  |  |  | P4 | P5 | P1 | P2 | P2 | P2 | P2 | P3 | P4 | P5 |
| 缺 | 是 | 是 | 是 | 否 | 是 | 是 | 是 | 是 | 否 | 否 | 否 | 是 | 是 | 是 |

（4）采用改进的Clock策略，如图，缺页异常次数为10次。

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 访 | P1 | P2 | P3 | P1 | P4 | P5 | P1 | P2 | P1 | P4 | P5 | P3 | P4 | P5 |
| 页  框 | P1 | P1 | P1 | P1 | P1 | P5 | P5 | P5 | P5 | P5 | P5 | P5 | P4 | P4 |
|  | P2 | P2 | P2 | P2 | P2 | P1 | P1 | P1 | P1 | P1 | P1 | P1 | P5 |
|  |  | P3 | P3 | P3 | P3 | P3 | P2 | P2 | P2 | P2 | P2 | P2 | P2 |
|  |  |  |  | P4 | P4 | P4 | P4 | P4 | P4 | P4 | P3 | P3 | P3 |
| 缺 | 是 | 是 | 是 | 否 | 是 | 是 | 是 | 是 | 否 | 否 | 否 | 是 | 是 | 是 |

（5）采用LRU策略，如图，缺页异常次数为7次。

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 访 | P1 | P2 | P3 | P1 | P4 | P5 | P1 | P2 | P1 | P4 | P5 | P3 | P4 | P5 |
| 页  框 | P1 | P1 | P1 | P1 | P1 | P3 | P3 | P4 | P4 | P5 | P2 | P1 | P1 | P1 |
|  | P2 | P2 | P2 | P2 | P1 | P4 | P5 | P5 | P2 | P1 | P4 | P5 | P3 |
|  |  | P3 | P3 | P3 | P4 | P5 | P1 | P2 | P1 | P4 | P5 | P3 | P4 |
|  |  |  |  | P4 | P5 | P1 | P2 | P1 | P4 | P5 | P3 | P4 | P5 |
| 缺 | 是 | 是 | 是 | 否 | 是 | 是 | 否 | 是 | 否 | 否 | 否 | 是 | 否 | 否 |

（6）采用MIN（滑动窗口t = 3），缺页异常次数为8次。

（7）采用WS（工作集窗口Δ = 2），如图，缺页异常次数为9次。